Are groups working in the Information Technology class?

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We discuss teachers' perception of the use of group work in the Information Technology (IT) classroom. We describe the current situation regarding the implementation of group work in IT classrooms in South Africa as well as the challenges that IT teachers face when implementing group work. This information will be used in further research to develop a training model for teachers and student teachers, which should enable them to apply group work effectively in the IT classroom.

Introduction and problem statement

Currently, employers are increasingly demanding that members of their work force be equipped with skills in team work and communication, since the workplace requires employees who can effectively work in teams (Van Rheede van Oudtshoorn & Hay, 2004:131). It is not surprising therefore, that the second critical outcome of the National Curriculum Statement (Department of Education, 2005:11) specifies that learners should be able to work effectively with other members of a group, in order to prepare them to function effectively within a group context in the work environment.

As in other industries, programme design in large organizations is normally performed by more than one person. Learners being taught programming skills, therefore, will also need training in group-work skills. In South Africa, programming and problem solving form part of the new subject Information Technology (IT), which has been approved in the Further Education and Training phase (Department of Education, 2005:11). Not only should these learners be developing the necessary social skills that will be required in their future working careers, but as a further advantage of working in groups they are enabled to complete tasks which they would have found difficult to do individually (Department of Education, 2005:12).

Grissom and Van Gorp (2000:258) found that collaborative learning could contribute to effective learning in the IT class, with Yerion and Rinehart (1995:30) ascribing this to the fact that collaborative learning fits in well with the problem-solving nature of IT as subject. Research demonstrates that learners benefit from co-operating in the process of problem solving (Grissom & Van Gorp, 2000:97), because they learn to think aloud, communicate with each other, and because they share a common goal. Learners are forced to ask questions, explicitly state, explain and justify their own ideas, articulate their reasoning and share each other's knowledge in an effort to solve a problem and design a programme (Veenman, Van Benthum, Bootsma, Van Dieren & Van der Kemp, 2002:87).

Despite research which demonstrates all the above learning benefits of

collaborative and co-operative group work, this is not generally used in South African schools in the teaching of IT or Computer Science/Computer Studies (Williams, Wiebe Ynag, Ferzli & Carol, 2002: 197-212; Yerion & Rinehart, 1995:29). Instead, there is still a strong tendency among teachers to depend on strategies which focus on the individual when teaching programming skills — they are generally inclined to favour individual problem solving and individual practice of programming skills.

Yerion and Rinehart (1995:30) underscore the fact that the accommodation of collaborative and co-operative learning strategies in the classroom demands particular inputs and planning on the part of the teacher. Specific goals must be set for groups to be successful in achieving the outcomes and the teacher needs to plan activities accordingly. This research therefore forms part of a research project to create a model according to which collaborative and co-operative learning can be effectively applied in the IT class. A training model will then be developed for in-service and student teachers which should enable them to use group work effectively in IT classes.

The following research questions guided this study:
- What is the current situation regarding the implementation of group work in IT classrooms?
- What are teachers' perceptions of group work?
- What are the challenges that IT teachers face when implementing group work?

Aim of the study

The aim of this study was to determine the current situation with regard to the implementation of group work in IT classrooms and the perceptions of teachers who apply group work in IT classes. A future aim will be to identify problems that IT teachers experience with group work.

This information will further assist the researchers in developing a training model for teachers and student teachers that should enable them to apply group work effectively in the IT classroom.

Literature review

Group work can be carried out in a number of ways. Although the terms co-operative learning and collaborative learning are often used interchangeably (McWhaw, Schnackenberg, Sclater & Abrami, 2003:71; Wilhelmsen, Asmul & Meinstad, 1998), there appear to be some differences. Nevertheless, no clear distinction can be made between the two terms. According to Panitz (1996) collaborative learning is a personal philosophy, not only a classroom technique, whereas co-operative learning is defined by a set of processes which help people interact together in order to accomplish a specific goal by developing an end product which is usually content specific. From the definition of Panitz (1996) it is clear that co-operative learning is more directive than collaborative learning, and is thus closely controlled by the teacher. Collaborative learning shifts the responsibility for learning away from the teacher, as expert, to the

student. Panitz states that many of the elements of co-operative learning may be used in collaborative situations. This is perhaps the reason that several interpretations of collaborative and co-operative learning exist. An overview of some views on the nature of co-operative and collaborative learning will be provided in this literature review.

Collaborative learning is about the effectiveness with which members of a group can apply their cognitive processes at interrelated levels in order to arrive at a solution. Therefore they work closely together, share common goals and resources and work together on a communal task, under conditions that involve both interdependence and individual accountability (Waite, Jackson, Diwan & Leonardi, 2004:12-13; Yerion & Rinehart, 1995:29-34; Grissom & Van Gorp, 2000:97; Anderson, 1998:202). Panitz (2000) confirms that with collaborative learning there is a sharing of authority and acceptance of responsibility among group members for the group's actions.

Co-operative learning is the instructional use of small groups in which students work together to maximise their own and each other's learning, in order to accomplish a shared learning goal (Johnson, Johnson & Stanne, 2000; Veenman *et al.*, 2002:87). It is regarded as a form of co-operation where each member of the group is responsible for a portion of the work, and it is directed at the effectiveness with which learning tasks can be subdivided in order to optimally utilise the various resources within the group, to create deeper insights and a broadening of knowledge (Wilhelmsen *et al.*, 1998). It also involves holding students accountable for their learning, as well as the learning of their group's members (Sonnier-York & Stanford, 2002:40).

In general the learning benefits of collaborative or co-operative learning are greater than the benefits gained from working individually. These learning benefits can be ascribed to cognitive factors such as availability of greater intellectual resources, as well as social factors such as an increased motivation for the task (Webb, 1993:133). Yerion & Rinehart (1995:29) state: "Sharing what we know exposes what we do not know or did not know that we knew. Working together also allows each individual's talents to serve as resources for everyone else."

With collaborative as well as co-operative group work, the group size could be as small as two members (pair or dyad, two-person group), or as large as 15, although Barker, Wahlers & Watson (2001:6-7) differentiate between a group, consisting of two, and groups consisting of three or more, as the purposes and interaction patterns of each differ. According to Barker *et al.*, (2001:6-7) the size of the group should be dependent on the maturity of the group, the style of the leader and personalities of group members. Watkins (2004:11) supports a group size of four to five persons as the possibility of "free-riding" increases significantly with the addition of members to the group. Barker *et al.*, (2001:6-7) stress the fact that there must be a face-to-face interaction among all group members.

Pair-programming as a learning strategy is a form of collaborative learning in which the group consists of only two members, the driver and the navi-

gator, who work together on one computer to complete the same project (Van-deGrift, 2004:2). Although literature reveals that pair-programming is mainly collaborative, quite a few co-operative elements exist to structure the learning process. Even though they work together to achieve a common objective, there are still individual responsibilities and roles to be played by each member. The driver is responsible for operating the keyboard, while the navigator directs the planning and problem solving. The navigator is constantly active in error analysis of the driver's work, thinking out alternatives, suggesting corrections, thinking out plans, solving problems, finding sources and assisting with design decisions (Hanks McDowel, Draper & Krnjajic, 2004:176). The results of the work by Williams *et al.*, (2002:197-212) indicate that students who do programming in pairs do better in programming projects than students working on their own. It is actually the purpose of pair programming to promote collaborative learning and prevent each member of the group from working individually (Williams *et al.*, 2002:197-199).

It is important for the successful implementation of group learning that group goals and individual responsibilities for each group member are emphasized (Slavin, 1996:54; McWhaw *et al.*, 2003:82). Veenman *et al.* (2002:88) stress the importance of assessing individual accountability to ensure that all group members participate. The results of the individual assessment need to be given back to the group as well as the individual (Johnson & Johnson, 1992:179). Individual accountability is important for group success, since some members tend to dominate and some to withdraw, unless mechanisms are in place forcing everyone to participate (Gross Davis, 1999:1). Positive interdependence refers, according to Strijbos, Martens, Jochems and Broers (2004:197), to the degree to which the performance of a single group member depends on the performance of all other members. Therefore positive interdependence of members of the group must also be dealt with in such a way that they realize that they will not achieve success unless all the members of the group achieve success (Johnson & Johnson, 1992:180). Each member needs to believe that they have a key role within the group and that the success of the group depends upon that (Brush, 1998:9). Johnson and Johnson (2006) believe that the teacher can strengthen positive interdependence in a co-operative group by giving each member a part of the total information required to complete an assignment. According to Slavin (1996:45)

> … the use of group goals and group rewards enhances the achievement outcomes of co-operative learning if, and only if, the group rewards are based on the individual learning of all group members.

This creates a situation in which learners realize that effective learning is a collective responsibility, where they share their resources, provide mutual support and encourage each other to achieve success (Veenman *et al.*, 2002: 89).

It is common practice to assign roles to each member of a group, not only in pair programming, but in any collaborative or co-operative group work situation. The main aim of roles in group work is to assign responsibilities to

group members and to avoid one member taking over the activity and others thus becoming passive observers (Wheeler, 1994). Roles can also be used to foster positive interdependence by dividing tasks among group members so that each member has a unique responsibility to complete the project (Brush, 1998:9; Slavin, 1996:47). Barker *et al.* (2001:45) define a role as a set of be-haviours that is expected by the individual who occupies a particular position in a group. Arslan (2003) suggests that different roles need to be assigned to dissimilar types of students. Wheeler (1994) suggests that the noisy learner needs to be the secretary and the sheepish learner the leader. Roles that could be assigned to each member include a leader, speaker, researcher and presenter (Wheeler, 1994). Grissom and Van Gorp (2000:99) mention three positions in a group, namely the scribe, responsible for recording the group conversation and final answer, the facilitator responsible for encouraging everyone to participate, and the speaker who needs to present the group's an-swer to the class. Gross Davis (1999:2) adds the role of a planner to outline where and how the group is proceeding through the assignment, as well as an evaluator to elicit critiques. There could also be other roles which depend, for instance, on the type of assignment, the group interaction and the group size.

It is generally taken for granted that pupils know how to work in groups and teachers only need to set assignments and facilitate the process. This as-sumption has proved to be false (McAllister, 1995:395-404; Sonnier-York & Stanford, 2002:41). It is necessary to teach students how to act in each role, how to take up the responsibility, how to share roles, how to set group goals, divide tasks and communicate with each other (McWhaw *et al.*, 2003: 78; 82). McWhaw *et al.* (2003:78) also suggest that training be combined with struc-tured group tasks to ensure that students learn to work together and get the opportunity to assume more of the management of their groups as they gain experience. Oliver and Omari (2001:46), who did their research on colla-borative learning in a web-based environment, also recommend that it is ne-cessary to provide students with structure and guidance in the organization and management of their groups. This further implies that the teacher/ facilitator should be thoroughly prepared by carefully designing and structu-ring group activities to achieve the necessary outcomes. During the group work activities the teacher/facilitator should also be available for consulta-tion, guidance, corrections and assessment (Yerion & Rinehart, 1995:29; Wheeler, 1994:48).

Method
In order to investigate the use of group work in IT classes and teachers' per-ceptions of a range of issues connected to the practical implementation of group work in the classroom, a detailed questionnaire on group work, comple-ted anonymously, was implemented during a training session on Delphi programming, organized by the North-West Department of Education, for IT teachers in the North-West Province (n=19) and at a meeting of Gauteng IT

teachers who acted as markers for the matric exams (n= 26). These teachers represented a convenience sample in these two provinces. The questionnaire consisted of open-ended questions as well as Likert-type questions, using a four-point scale. The questionnaire consisted of six different sections. The first section dealt with the extent to which group work had been implemented, the second with learners' perceptions of group work (according to the teacher), the third with ideal group size, then the assignment of roles, the possible collaboration of learners and lastly the problems that teachers encounter with group work.

The content validity of the questionnaire was assured by requesting several experts in the field to scrutinize the instrument to ascertain its validity for measuring the characteristics in question. Furthermore cross-checking questions also assisted the researchers to determine the consistency of responses (see Table 1, questions 4 and 7). In an introduction to the questionnaire used, it was pointed out to participants that there were no "wrong" or "right" answers to any of the questions, and they were encouraged to have their answers reflect what really happened in their classrooms, as opposed to what they might think should be happening. The aim of these instructions was to try and prevent teachers from insinuating compliance with the teaching methodology, in spite of not doing so in practice.

Descriptive statistical methods were used to analyse the responses. Due to the fact that no significant differences between the responses of teachers in Gauteng and teachers in the North-West Province were detected when the effect size between the averages of the two groups was determined, the responses of the two groups were used together in the interpretation of the data. Only one question showed a significant difference between the two groups and this question is discussed separately in the appropriate section.

Results

In Table 1 teachers indicated the extent to which they implemented group work in their IT classes. Based on the response to question 2, only 18% of teachers used group projects frequently or daily for assessment purposes. This low percentage was significant in view of the fact that the National Curriculum Statement expects of IT teachers to use group work in this way.

Although 69% of the teachers indicated that they tried to stimulate the learners' ability to collaborate with others, it was contradicted by the fact that only 33% of teachers indicated that they regularly, or on a daily basis, used groups of learners working co-operatively when teaching IT. Only 47% of the teachers indicated that learners got the opportunity on a regular or daily basis to work together in groups. The response to the question: "To what extent do you allow learners to help each other?" explains the apparent contradiction. Seventy-eight percent of the teachers indicated that they allowed learners to help each other on a regular or daily basis, whereas only 49% indicated that their teaching practice allowed small group activities on a regular or daily basis. This could be how they tried to stimulate the learners' ability to colla-

borate with others, but this collaboration was not necessarily group work. Seen in the light of the responses to question 4, where 66% of teachers indicated that they never or seldom used group work in the IT class, one could assume that the teachers' perception of collaboration was not only group work. Although most of the teachers (62%) felt themselves equipped to use group work in the IT class on a regular or daily basis, it was not reflected in the answer to question 7 where only 49% indicated that they created the op-

Table 1 The use of group work in IT classes

Question (n = 19)	Not at all/ Never		To a slight extent/Some times		To a large extent/ Often		In totality/ Daily	
	f	%	*f*	%	*f*	%	*f*	%
1. To what degree is the development of learners' ability to work with other people encouraged by the way you teach?	1	2	13	29	25	56	6	13
2. To what extent are group projects used for assessment in your Information Technology class?	2	4	35	78	8	18	0	0
3. To what extent do you make use of groups of learners that work together co-operatively in teaching Information Technology?	6	13	24	53	13	29	2	4
4. How often do the learners in your Information Technology class get the opportunity to work in a group with other learners?	3	7	21	47	17	38	4	9
5. To what extent do you make use of learners helping each other to develop critical thinking skills in learners?	0	0	12	27	25	56	8	18
6. To what extent do you feel yourself confident to make use of group work in the presentation of your classes?	1	2	16	36	22	49	6	13
7. To what extent does your classroom practice allow for small group activities?	2	4	21	47	19	42	3	7

portunity for learners to work in small groups on a regular or daily basis. This was in spite the fact that group work was one of the outcomes stated in the National Curriculum Statement and expected of IT teachers as a teaching strategy.

In Table 2 the learners' practice, according to the teachers' experiences, showed that 65% of learners liked to work together in groups. Teachers were also asked to give reasons why learners liked or disliked working in groups. Learners who were uncertain what to do or struggled to achieve the outcomes, wanted to work in groups and exchange ideas while high achievers disliked group work and preferred to work alone. Some reasons for this, according to the teachers, may have been that they worked faster than the rest and got bored and frustrated working with slower learners. Some teachers mentioned that learners felt that they could help each other to prevent the stress on one person; also that it was more informal and enjoyable to work together and that they understood difficult concepts more easily because they could explain them to each other. Some children loved to explain the work to fellow learners. If they solved problems together, they remembered the way to do it better and they had the courage to ask more questions of peer learners. It helped to understand the problem better if learners discussed it together. Two teachers (4%) indicated that learners wanted to work in groups when they needed to complete practical projects, but not with theoretical work. Learners disliked reporting back in front of the class. The reason that some students disliked working in groups was, according to the teachers, mainly because some students were passive observers, who felt incompetent amongst stronger learners. According to one teacher, about one out of ten learners did not like working in a group, due to their personalities — the others clearly enjoyed finding solutions in a co-operative manner.

Table 2   Learners' perspectives according to teachers

Question 8 Do learners in your Information Technology class like working in a group with other learners?		
Options	*f*	%
Yes	29	65
No	14	31
Seldom	2	4

The results reported in Table 3 indicated the ideal number of group members, according to the teachers. It is interesting that the majority of teachers (44%) indicated that three learners working together was the ideal number. Only 29% of teachers indicated that two learners were the ideal group size and 20% indicated that four learners were the ideal group size. The low percentages for responses on this question showed that teachers were not con-

vinced about the ideal group size. This only indicated that they were convinced that group sizes should not be more than five.

On the question of whether specific roles were assigned to each member of the group, the teachers of North-West and Gauteng had different opinions.

Table 3 Group size

Question 10 What, according to you, is the ideal number of group members for group work in a Computer Studies/IT class?		
Size	*f*	%
Two	12	29
Three	18	44
Four	8	20
Five	3	7
More than five	–	–

Only 42.1% of the teachers from North-West assigned roles to members of a group, while 73.9% of Gauteng teachers assigned roles to the group members. Table 4 indicates the number of teachers that assigned specific roles to each member of a group. The majority of teachers (59.5%) do assign specific roles to each member of the group. Teachers had to indicate the different roles assigned to learners during group work activities. Responses of teachers are given in Table 5. The responses indicated that teachers in both Gauteng and North-West provinces lack theoretical knowledge of group work and do not know the different roles that can be assigned to learners working in groups. Only 22 teachers (49%) indicated a leader as a common role for members of a group. The rest of the roles listed were only suggested by a few teachers and do not represent a significant part of the sample. According to the literature, bad performers, parasites, lazy learners, assistant, hard workers, etc., are not roles normally associated with group work. The responses to this question indicate that most teachers only use a leader when assigning learners in groups. Van Rheede van Oudtshoorn & Hay (2004: 135) stated that group work seems to be a waste of time unless one assigns specific roles to each member of a group.

Table 6 shows teachers' responses to the question on how learners in their IT classes helped each other with programming. The highest percentage (31.1%) listed the fact that learners shared ideas and tips to solve problems. Eight teachers (17.8%) indicated that learners explained the problems to each other. Some mention that they showed each other their mistakes (17.8%) and in some instances the expert learners assisted the bad performers (15.5%), they communicated with each other (11.1%) or discussed the problem together (8.9%) or learners simply copied from each other (4.4%). It should be mentioned that the activities mentioned as response to Question 13 could not

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Table 4 Assignment of roles: North-West teachers, Gauteng teachers and total group analysis

Question 11
Is a specific role assigned to each member of the group when group work is implemented?

Choice	*f*			%		
	N/West	Gauteng	Total	N/West	Gauteng	Total
Yes	8	17	25	42.1	73.9	59.5
No	11	6	17	57.9	26.1	40.5

Table 5 Different roles

Question 12
Name the most common roles assumed by learners when they work in groups

Response	*f*	%
Leader	22	49
Researchers	6	13
Follower	5	11
Reporter/Presenter	5	11
Parasite	5	11
Scribe	4	9
Typist	3	7
Workers	3	7
Observer	2	5
Criticisers	2	5
Listeners	2	5
Time keepers	2	5
Planner	1	2
Participant	1	2
Lazy learners	1	2
Hard working learners	1	2
Bad performers	1	2
Best performers	1	2
Assistant	1	2
Negotiator	1	2
Tutors	1	2
Slaves	1	2
Assessors	1	2
Secretary	1	2
Motivators	1	2

Table 6 Collaboration among learners

Question 13
How do learners in your Information Technology class help
each other with programming?

Response	*f*	%
Share ideas and tips to solve problems	14	31.1
Explain the work to each other	8	17.8
Show each others' mistakes	8	17.8
Expert learners assist bad performers	7	15.5
Communicate with each other	5	11.1
Discuss problems together	4	8.9
Copy from each other	2	4.4

necessarily be considered group work. Van Rheede van Oudtshoorn and Hay (2004:135) warned that a group, sharing the same table and doing their own work but free to talk to one another as they work, is not structured to be a co-operative group, as there is no positive interdependence.

Problems that teachers experienced with the implementation of group work are listed in Table 7. The most significant problem listed was discipline (22.2%). According to the teachers, group work changed into a discussion over irrelevant topics, learners tended to talk and relax too much and therefore it became a bit disorganised and noisy. Non-participating learners who merely copied the work done by their group were also a problem, indicated by 20% of the teachers. Some teachers (13.3%) also indicated that one person normally did all the work. Other problems identified by some teachers were the fact that it took too much time to do group work, that stronger learners were penalised by the lack of co-operation from weaker learners, that some teachers did not have enough room in the class for group work, that learners did not want to be divided into groups but wanted to choose their own partners and that some learners "*disappeared*" in the group. The stronger learners tended not to support group work and preferred to work alone. The problem of learners copying each other's work also existed in some IT classes. It was clear from the responses that teachers lacked theoretical knowledge of group work as they did not apply positive interdependence and individual accountability in their group work activities.

Discussion

Although the majority of the teachers indicated that they saw themselves as capable of implementing group work in their classes, this was contradictory to the rest of the data showing that most of the teachers were unaware of the fact that they should allocate specific roles to each member of the group and that positive interdependence and individual accountability were cornerstones in the success of group work. If they built in positive interdependence, individual responsibilities and group aims into group work activities, a lot of the

Table 7   Problems with implementation

Question 13
How do learners in your Information Technology class help each other with programming?

Response	f	%
Discipline (Group work changes into a discussion over irrelevant topics, learners tend to talk and relax too much. It is a bit disorganised and sometimes a bit noisy).	10	22.2
Weaker pupils and lazy pupils ride on the backs of the others (They wait until the others have finished their work, then simply copy it. Thus some of the pupils rather want to do the project individually).	9	20.0
One person doing all the work	6	13.3
Group work takes up too much time	3	6.7
Stronger pupils penalised by lack of co-operation from weaker pupils.	3	6.7
Not enough room	2	4.4
Learners don't like the idea of dividing into new groups.	2	4.4
Difficult to monitor groups in big classes	2	4.4
Some pupils disappear in the group	2	4.4
One computer cannot accommodate big groups successfully. The pupil that types becomes separate from the group.	1	2.2
Some learners do want to work individually, because they find group work too unproductive.	1	2.2
Learner is not used to group work	1	2.2
Children want to listen passively, not participate in an activity.	1	2.2
Every pupil wants to do it his or her own way.	1	2.2
The activity is above the learner's problem-solving capabilities.	1	2.2
Absences of assigned group members	1	2.2

identified problems would probably decrease. For example, one pupil cannot do all the work, because all the other group members would be penalised. If group work is well planned, it should never turn into noisy confusion, because everyone is motivated to be successful in the group. Teachers did not realise that group work had a strong theoretical foundation. There was a major difference between group work as a technique on the one hand and a discussion among learners who experienced problems with an individual assignment.

Conclusions

Teachers' responses to the questions indicated that there was a definite need for a model for the implementation of group work in the IT class. Not only were teachers uninformed, but they did not seem to appreciate the dynamics of group work and the contribution that group work could make to effective learning and teaching in the IT class. Without informed teachers there will be no effective group work. Learners should be able to work effectively with other members in order to prepare learners to function effectively in a group context within the work environment. It is therefore of the utmost importance that teachers be trained in effective handling of group work in the IT class.

Acknowledgement

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