

Educational implications of Vygotsky's *zone of proximal development* on collaborative work in the classroom.

For many years it has been generally agreed that collaborative work in classrooms has positive cognitive and social outcomes. A myriad of research and discussion can be found on this: e.g. Kerry and Sands, 1982; Rogoff, 1990; Freund, 1990; Biott and Easen, 1994; DeVries, 2000; Foley, 2002. In their book *Group Work in the Primary Classroom* Galton and Williamson (1992) cite a number of experiments from the 1980s that provide empirical evidence for successful task completion through group work. Much of this research has its roots in the social-cognitive school of developmental psychology founded on the theories of psychologists such as Lev Vygotsky (1896-1934).

During his short life, Vygotsky worked actively in the field of psychology producing numerous influential texts¹, most noticeably *Thought and Language* published in Russia during 1937 (translated into English in 1962). Jerome Bruner in his introduction to Vygotsky's *Thought and Language* (1962: p.5) writes that it is a presentation of highly original and thoughtful theory of intellectual development. Vygotsky's conception of development is at the same time a theory of education. This essay will in part discuss the far reaching effects of Vygotsky's theory on education. In *The Collected Works of L. S. Vygotsky* (Volume 1: 1987: p.16) Bruner extends his complement stating that Vygotsky was one of the great theory makers of the first half of this century along with Freud, McDougall, Piaget, and a very few others. Like them, his ideas are situated in his times. But like the best of them, those ideas still point the way to the future of our discipline. "

The discipline for the purpose of this assignment shall be education. This essay will look at Vygotskian and neo-Vygotskian theories focusing on the *zone of proximal development* and discuss the implications for classroom based learning. Some issues will also be accompanied by illustrations from a secondary school music stance.

Vygotsky based his paradigm of learning on collaboration stating that work with a more cognizant person is pertinent to development: Cognitive processes are the result of social and cultural interactions. (Vygotsky, 1978: p.84) Vygotsky famously observed that:

Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, *between* people (*interpsychological*), and then *inside* the child (*intrapsychological*). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relations between human individuals. (*ibid*: p.57)

Thus, according to Vygotsky, the aetiology of learning is social interaction: a concept is first presented to a child socially (interpsychologically) either by parent, peer, or teacher, later to appear *inside* the child through the process of internalisation. As educators, we must strive to promote social interactions that are as conducive to learning as possible. Before examining the constituents of an appropriate social setting, an account of Vygotsky's theory and two forms of classroom interaction will be discussed.

¹ *Pedagogical Psychology* (1926; in Russian), *Thought and Language* (1937; translated into English in 1962), *Selected Psychological Studies* (1956; in Russian), *Development of Higher Mental Processes* (1960; in Russian). *Psychology of Art* (included some of his papers: 1965; translated into English 1971).

In developing his theory of the zone of proximal development, Vygotsky examined the difference between the actual age of development (i.e. what a child can achieve independently) and the potential development range demonstrated when collaborating with a more capable person. If only the unaided endeavours of a child are observed, what manifests is an inadequate portrayal of the child's developmental level. Instead, what would be seen are the child's cognitive tools which are already in a mature state. Vygotsky uses the following analogy to elucidate this:

Suppose I investigate two children . both of whom are ten years old chronologically and eight years old in terms of mental development. Can I say that they are the same age mentally? Of course. [.]. These children seem to be capable of handling problems up to an eight-year-old's level, but not beyond that. Suppose that I show them various ways of dealing with the problem. [.]. Under these circumstances it turns out that the first child can deal with problems up to a twelve-year-old's level, the second child up to a nine-year-old's. Now, are these children mentally the same? (1978: pp.85-86).

This problem poses educators questions regarding the validity of individual assessment when assessing pupil ability. Vygotsky's theory suggests that teachers must not limit their analysis of development to inner functions that have matured; instead, tools or functions in the process of maturing should also be taken into account (Vygotsky, 1987)². The *National Curriculum for Music*³ indirectly accounts for this by stipulating that music must be taught (and therefore assessed) through tasks involving pupils working on their own, in groups of different sizes and as a class (QCA, 1999: p.21). Through such tasks, music teachers are able to ascertain pupils' individual ability and potential ability when working in groups, therefore gaining a more comprehensive representation of each child's ability. In a lesson examining improvisation using Indian ragas, pupils might first be assessed improvising on their own and then complete a holistic task in groups.

It can be seen from Vygotsky's work that the key to his theory of development is the difference between mature and maturing cognitive tools. It is from this notion that he developed the term *zone of proximal development* (ZPD). Vygotsky defined this zone as the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978: p.86). It is this concept that advocates of group work see as being intrinsic to development. It was also this paradigm that placed Vygotsky alongside names such as Piaget⁴ in the pedagogical world.

Arguably, most teachers in England (especially those that are newly qualified) will be acquainted with Vygotsky and at least his *zone of proximal development* as a result of the psychological theory injected in most teacher training courses⁵. It is therefore natural for teachers to draw on their knowledge

² Further discussion of assessment of (or in) the zone of proximal development can be found in Leat and Nichols (1997), and Allal & Ducrey (2000).

³ The *National Curriculum for England: Music* can be found at <http://www.nc.uk.net/nc/contents/Mu-3---POS.html> (12/03)

⁴ It is interesting that although Piaget's theory differs from that of Vygotsky on many levels, Piaget sounded much like Vygotsky when he stated that: 'relations among individuals . modify the mental structures of individuals' (1950/1995 p.40: cited in DeVries (2000) p.190). For a detailed comparison of both theories, see DeVries (2000).

⁵ It goes without saying that knowledge of the psychology of learning at some level is required in order to teach. The standards proposed for teacher training by the *Teacher Training Agency* allude to this, albeit in an indirect way: 'They [teachers] understand how pupils' learning can be affected by their physical, intellectual, linguistic, social, cultural and emotional development' (Standard 2.4), and 'They know a range of strategies to promote good behaviour and establish a purposeful learning environment' (Standard 2.7). (TTA, 2003: p.9)

of theory and research when constructing their own teaching method. How can Vygotsky's ideas be developed and utilised for classroom use?

First, it should be noted that there are many problems with trying to draw educational implications from Vygotsky's theory. Vygotsky never stated what form of social interaction constitutes assistance to a learner in the ZPD. Moreover, the idea of facilitating development through collaboration is neither behaviourist nor constructivist therefore a teacher may provide ordinate, authoritarian furtherance as well as nondirective, cooperative assistance (DeVries, 2000). Ordinate, authoritarian furtherance may involve a teacher or teaching assistant working within a group to steer pupils towards a preconceived goal. Without the social/group interaction, the individual pupil might not be able to achieve this goal, but by working as part of a group (i.e. with pupils or the teacher/assistant acting as the more cognizant partner) the pupil's potential development can be accessed. The adult, by acting authoritatively, might attempt to channel conversation and deliberation towards the truth or sought skill. A potential problem with this method is that ownership over learning is taken away from the child and the child can become over reliant on adult support.

A possible solution to this problem is *scaffolding*, proposed by Wood, Brunner, and Ross (1976). This refers to the context provided by the expert partner working within the novice's ZPD. Wood gives an example of scaffolding in a task completed by three-to four-year-olds working with their mothers to create a pyramid out of wooden blocks and pegs:

Young children succeeded with help, where alone they failed, because the tutor performed a number of functions which kept the child on task whilst they learned. For example, tutors lured the child into task activity by a variety of tactics, such as showing them how pegs fitted into holes. They often simplified problems facing the child by helping them to select pieces, by showing them how to re-view objects by turning them around, and so on. (Wood, 1998: p.99).

In simple terms, scaffolding involves reducing the degrees of freedom with which the child has to cope, utilizing tactics to focus attention, and providing models of the expectation. The expert should also intervene to prevent the child regressing (Brunner: 1978), and work contingently within the ZPD. The most important aspect of scaffolding to the present problem is that support from the expert is gradually reduced as the novice's knowledge and confidence increases. Over time, the child becomes less reliant on the expert although ownership over the given task may never be within the child's reach.

An example of scaffolding in music teaching can be seen in the following case study in which year seven pupils are introduced to *listening*⁶ for the first time:

Pupils are given a variety of pieces to listen to and comment upon in regards to expressive use of musical elements, devices, tonalities and structures (QCA, 1999: p.20) Pupils' responses should utilise correct vocabulary to gain the lower levels (L3-4) and discuss context, effectiveness, and culture to gain the higher levels (L5-8). In my experience, Year 7 pupils seem to find this parameter of music the most difficult as their musical vocabulary and experience of musical genres is limited⁷. At this level, pupil answers to open ended questions such as describe features of this piece that make you think of war usually deal with superficial rudiments of the music being played or an inaccurate discussion of salient musical elements employed. To aid

⁶ *Listening* is the final component of the four parameters of musical experience addressed by the National Curriculum. Swanwick refers to it as Audition: responsive listening as (though not necessarily in) an audience. (1979: p.45).

⁷ This is most likely the result of the lack of music specialists teaching at primary level and the short periods of time allocated to music over the school year.

pupils' efforts key vocabulary with meanings are written on the board or posters are placed around the classroom. Through discussion of the prompts given, pupils are taught musical elements such as pitch, harmony, melody, instruments, rhythm, tempo, and dynamics. Each element requires the use of specific vocabulary which are discussed and written under the appropriate heading. Alongside the key vocabulary, a proposed answer structure is given on the board such as: The ..[*musical element*] .is/are ..[*appropriate vocabulary*] .which might represent ..[*some relevant aspect of war*]. Through this process of scaffolding, pupils are able to draw more appropriate conclusions like: The percussion instruments used are snare drums which make me think of soldiers marching into battle. As year seven progresses and different topics are taught, pupils build up a vocabulary list at the back of their books that, by the end of the year, they are able to use during listening tasks without the aid of the aforementioned prompts. Therefore, the teacher's intervention and guidance is gradually reduced.

Aside from ordinate, authoritarian furtherance, a teacher or classroom assistant may give nondirective, cooperative assistance to pupils working in groups. The teacher may mediate learning indirectly through the structure of learning activities or resources/tools provided to the pupils (Allal & Ducrey, 2000). The teacher may also devise a task in which pupils are free to be creative with their learning: a task may have a goal such as the development of a skill but it is the group's volition as to how that goal is achieved. The adult only intervenes to cooperate with the child in their chosen path or to prevent coasting or regression. Such a method can be found in the following musical task in which the learning objective is for pupils to develop their performing and composition skills.

Task:

Pupils work in groups of four to create and perform a circus composition using various instruments. Each child is given one circus act (clowns, acrobats, tightrope walker, or the circus band) to represent in music. Pupils work in groups helping each other devise their various vignettes before the final performance in which the group performs to the class with the circus band played before and after each act. During each group performance, the rest of the class are given an appraisal sheet, effectively marking the group using set criteria. The task seeks to develop pupils' awareness of different stimuli for musical compositions and enhance improvisation/composition and performing skills.

Method:

After explaining and setting the task, the teacher circles the various groups and listens to the various conversations and musical ideas presented by different children. The teacher's comments are nondirective seeking to draw out reasons behind pupils' thoughts or posing questions to facilitate thinking about the various stimuli. The teacher should cooperate with pupils in their endeavours by praising good work and making suggestions, but at all times the pupils are free to pursue the goal (i.e. the final performance) in whatever way they see fit.

This particular task is included in a Year 7 unit on Russian music which I have taught in the manner mentioned above a number of times. What is interesting is that the freedom given to the children results in very varied compositions within a class. One group might have chosen to perform each act using the whole ensemble to accompany the selected soloist, whilst another group might decide to have each act performed as a solo and the band composition played by the whole. If the

task is to take two lessons before assessment, works in progress can be shown at the end of the first stage. This results in the collaborative effort being extended beyond the individual group because one group using brass sounds for the band might cause other pupils to question why that might be effective. What is most fascinating about this particular collaborative effort is the high level of motivation with which all pupils appear to approach the task. I believe that it is the organic nature of the task created by the freedom and ownership given to the pupils that is one of the greatest motivational tools presented by this particular unit.

A further issue raised by this particular task came about through an observation of one less-able pupil who was taught a composition to play by another more-able pupil within the group. This was of detriment to the learning objective as the less-able pupil's composition skills were not being developed. This concern proved to be trivial as the performing skills developed by the less-able pupil whilst working with a higher level composition resulted in more fruitful attempts in later units. One could surmise from this that the developed performing skills resulted in a better familiarity with the instrument in future composition tasks, plus it presented a model for what could be achieved.

It should be noted at this point that such examples of collusion can be the undoing of individual development if not recognised by the teacher. Authorship of work can be even harder to ascertain after the collaborative effort as a result of what Ratner, Foley, and Gimplet (2002) call source monitoring errors. They state that in some collaborative exchanges children can recode the actions of their partners as if they were performing the actions themselves: Children appeared to recode the other person's action, making them their own, and then subsequently took credit for the actions. (Ratner *et al* 2002: p.46). With this in mind it is therefore essential that the teacher's freedom provided by Reid's flexible bass (see below) is employed efficiently. In addition to concentrating on the less able, the teacher should strive to circulate and discuss each pupil's work whilst using what is referred to in the Hay Mober report as the lighthouse effect (DfEE 2000: section 1.2.8) to listen carefully to group discussions.

The implications of Vygotsky's theory are extensive and as mentioned, much research has been conducted on collaboration. Aside from the cognitive benefits Reid *et al* (Reid, Forrestal, and Cook 1982) suggest that group work benefits pupils socially, emotionally and cognitively. Through experience, pupils can learn many subsidiary skills as a by-product of the collaborative effort. Such skills as synthesis, reasoning, delegation, and deliberation can be developed alongside the intended cognitive goal of the task. Also, by becoming involved in the learning process, pupils can take ownership not only of the task but also of their own learning. By doing so successes can breed their own rewards as pupils meet personal targets. Obviously, for such auxiliary learning to take place, the social setting has to be closely monitored by the teacher. It is all too easy for a socially weaker member of the group to fall outside the collaborative effort if they feel intimidated by their peers or unable to contribute. It is therefore essential to the aim that the overall learning environment established in the classroom is enabling and celebrates differences of opinion so that the same ethos pertains in smaller groups.

Reid *et al* also point out that group work provides a manageable and flexible bass from which the teacher can work to provide the best learning experience for the class. (1982, p.5) In its most basic sense, a flexible bass might enable the teacher to focus on less-able pupils devoting more time to individual help. This is particularly difficult with teacher-focused learning as the teacher is engaged with a much larger group.

Although group work in the classroom can be a valuable tool, Vygotsky's paradigm is not limited to collaboration between peers. One cannot get away from the fact that a high proportion of teaching is conducted from the front of the classroom; in fact much early research conducted after the

resurgence of interest in Vygotsky's theory concentrated on the role adults play in children's development (Rogoff & Wertsch, 1984; Valsiner, 1987; Wertsch, 1985; Bliss, Askew, and Macrae, 1996; Jarvis & Robinson, 1997). A large proportion of this research has shown the advantages of adult-child collaboration over peer-peer work. Rogoff (1990) points out that 'Adults may be able to carry out metacognitive or metamnemonic roles that are beyond children, while demonstrating to children how such processing can be accomplished' (p.160). This is significant for classroom practice as many advocates of group work employ adult-focused teaching for the conceptualization of complex notions whilst reserving group-work activities for the assimilation of such concepts or key skills. In a musical setting, the teacher might reserve whole-teaching didactic teaching for learning the rudiments of notation whilst initiate group work for the conversion of *Frere Jacques* from a rote learnt song into conventional notation.

With both peer and adult/pupil interaction now addressed it is essential to look at latent drawbacks of interaction in the classroom. A potential shortcoming of adult/pupil interaction relates to the unequal power relations. Piaget notes: 'The child's socialisation with his fellows is greater than, or at least different to, his socialisation with adults alone. Where the superiority of the adult prevents discussion and co-operation, the playfellow provides the opportunity for such social conduct as will determine the true socialisation of the intelligence.' (Piaget, 1926: p.258, cited in Rogoff, 1990: p.147). Would a child be more willing to accept a cognitively conflicting view from an adult partner than from a more cognizant peer? It goes without saying that very young children would be affected as the result of the unequal power balance created by working with an adult, but the validity of this statement should be questioned when related to a secondary school child. Owing to the diverse socio-economical and cultural background of secondary school children, pupils arrive at secondary school with differing expectations of adults and how they behave; they have also developed greater theory of mind than their younger counterparts. In the present cultural environment, pupils are more willing to question their teachers over concepts presented that are in conflict to their own belief. Animated (but positive) discussions between pupil and teacher can be found in many secondary school classrooms; furthermore they can be the genesis of achieving Piaget's 'equilibrium in thought'. That said, it must be recognised that this does not apply to all children and that 'teacher status' will always play a significant role in this debate.

Tudge poses the question: 'When an adult provides information within a child's zone of proximal development, development may indeed result, but can we be as certain about the outcome when peers interact?' (Tudge, 1990: p.158) To answer this we shall look at a number of experiments that Rogoff (1990) cites in which children of various ages work with adults or peers in planning and memory tasks (Ellis & Rogoff, 1982, 1986; McLane, 1987; Koester & Bueche, 1980; Radziszewska & Rogoff, 1988). It emerges from these experiments that most 'child teachers' seem insensitive to their partner's need to learn and too often take over the task without clearly modelling the aim. Few child teachers seek to assess their partner's understanding of the rationale behind the assignment, but instead focused on accomplishing the concrete task. Adult interaction, on the other hand, tends to result in efficient guided involvement: providing links between the child's current and required knowledge, structuring the task, and guiding the child in decision making that was within their ZPD.

The conclusions drawn from these experiments do not favour adult-child collaboration over guided participation with another peer as in each case the 'child teacher' was not as skilled as the adult. The experiments do not account for children that have training or practice in interaction skills nor do they account for tasks that are open ended or in which a child could have similar understanding and skill as the adult. Such circumstances can be found in music education when a child's 'musical vernacular' can be just as wide and varied as an adult's. What these experiments do show is that intersubjectivity

between partners might be more important to successful interaction than the status of the more cognizant partner.

The positive affects of successful peer collaboration on the novice have been discussed, but one has to ask the question what benefit (or detriment) does such a collaboration have on the expert? To examine this question we have to begin not from a Vygotskian base but from Piaget-inspired research. Siegler (1976, 1981: cited in Tudge, 1990: pp.160-163) conducted a Piaget-based experiment in which children engage in predicting the workings of a mathematical beam (see *Appendix I*). This particular task was chosen to enable children's thinking to be assessed on a six level scale during an individual pretest experiment (see *Appendix II*). For the treatment phase, children were then paired with either a partner assessed to be using a lower level, the same level, or a higher level. Through the process of intersubjectivity, each pair would predict the workings of the mathematical beam a number of times without feedback. Following this, the children were retested individually at two later dates to assess the effects of the collaborative process.

The findings are rather disturbing for any neo-Vygotskian as a marked regression in cognition occurred in many expert and equal partners as a result of working with novices. Tudge notes that: 'Development, far from being teleological or unidirectional, must be viewed as context-dependent. In this case, one must accept that if a child is interacting with another person who is less competent the result of that interaction may be regression' (Tudge, 1990: p.158). The ZPD should therefore be thought of as existing around a child and not necessarily just in front. Vygotsky unknowingly gave warning of this when he famously professed that 'good learning is that which is in advance of development.' (Vygotsky, 1978: p.89). From the above it can be deduced that apprenticeship is only of benefit to the novice because the skill being learnt can only be in one child's ZPD. The expert would require another partner of greater skill to foster their own development.

To assess the cultural validity of Siegler's experiment, Tudge repeated this study in the Soviet Union reaping similar conclusions (1989, cited in Tudge, 1990). Tudge also looked at how confidence might affect the course of regression or development by using the six levels as a guide. Levels 2 and 4 allow children to assess the workings of the beam with more confidence than levels 1, 3, and 5 (see *Appendix I*). He concluded that a child working at level 3 (lacks confidence) could progress if working with a partner of level 4 (confident) but was likely to regress if working with a partner at level 2 (confident). The reverse applies: a child working at a confident level (2 or 4) is unlikely to change their perception.

Before assessing these findings in relation to teaching, it is important to note that at no time was feedback given to the children, either verbally or by the balance beam⁸. In a second study, Tudge sought to rectify this by using the beam to provide feedback. It seemed from the new results that the majority of children who received feedback improved on retesting. The implications for teachers are twofold: on the one hand, teachers could attempt to create tasks that do not promote confidence at any level; on the other, either the material or the teacher should regularly give appropriate feedback. The former, apart from being undesirable, is almost impossible to administer in most areas of education. It is possible that a musical task could be devised providing that it was very open ended and that models were given by the teacher throughout the working process. Even so, it is almost impossible to expel any level of confidence as a child could devise a pastiche of their favourite popular (but undemanding) tune and be confident in their work⁹.

⁸ The balance beam remained locked by two wooden supports which prevented the children assessing the accuracy of their predictions (see *Appendix I*).

⁹ It is unfortunate that this confidence can be a big barrier in GCSE composition in which pupils are able to compose their own dance re-mixes. Many of the examples that they are familiar with are of limited musical quality and would not achieve

The second implication (giving feedback) is more practical to teaching. Tudge's experiment suggests that feedback is an integral constituent of a developmentally successful social situation; for the expert to progress feedback must be given throughout the collaborative process. In some cases feedback may issue from the task or the material which musically would require the task to be closed and possibly built in stages. Arguably, feedback is more effective when given verbally as it can be pitched at the correct level and induces discussion. Tudge's second study (1990: pp.165-167) does not account for this; further research is needed to assess the difference between impersonal and interpersonal feedback.

In addition to the importance of feedback, there are a number of other issues that need addressing relating to creating a suitable social setting for learning. Fisher (1993, cited in Tin 2003) investigates the type of discussion that emerges when pupils collaborate eliciting three types: disputational, cumulative, and exploratory. Disputational discussion represents disagreement and individual decision making whilst cumulative talk characterises the accretion of ideas without intersubjective discussion. Exploratory talk is the more favourable as individuals impugn ideas until intersubjectivity is complete. From this, one can conclude that teachers should strive to create situations which induce exploratory talk. It is unlikely that exploratory talk will be initiated if relevant expert knowledge is not present in at least one member of a group. This relates directly to Vygotsky's notion of work within the ZPD and confirms the importance of how pupils are allocated to groups. It is suggested that musical group work reaps best results when the teacher selects the groups enabling him/her to create mixed ability groups in which there is at least one expert pupil. When necessary, it is important to split friendship groups as pupils working with friends can seriously impede the creation of balanced ability groupings. Rubin *et al.*, (1994) suggest that children tend to form friendships with others of similar age, race, sex, outlook, and intelligence. It is therefore sometimes necessary for the teacher to intervene if there is an imbalance of ability in a single group.

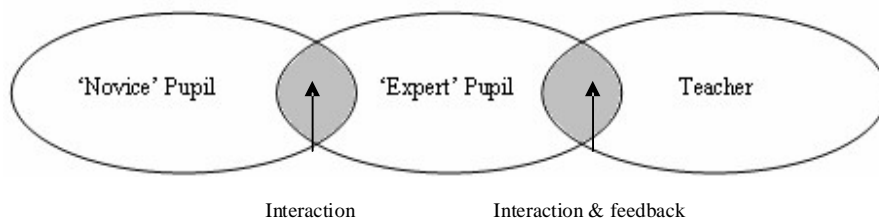
When creating groups teachers should also be aware that each child possesses individual funds of knowledge (Moll & Greenberg, 1990) that is knowledge that an individual obtains from the culture in which they develop including concerns, interests, skills and competences. Teachers aware of such funds should strive to utilize them when selecting individuals for groups as they can help bridge gaps in expertise that might otherwise prevent exploratory talk (Nieto & Rolón, 1997: cited in Rueda and Monzó, 2002, p.505). By putting pupils with diverse expertise and knowledge together, they can each bring something distinct to the task: knowledgeable participants can act as more capable peers at various stages to help the group solve the problems and complete the tasks successfully (Tin, 2003, p.65). This is particularly important for sustaining motivation in pupils that would otherwise be regarded as less able. In a musical context, a seemingly low-ability child with an Indian background may be able to bring a rich fund of knowledge to a group developing stylistic awareness of Bhangra music.

Funds of knowledge have implications not only for the creation of groups, but also when building units of work and tasks. By devising tasks that address cultural and popular issues, teachers are able to access these funds of knowledge and sustain motivation as well as encourage (through group work or otherwise) children to respect each other's strengths and weaknesses. Music is a good example of a subject that is able to acknowledge funds of knowledge because the *National Curriculum* stipulates that: pupils should be taught the knowledge, skills and understanding through a range of . . . music from

high marks. When creating such a piece, the confidence created by a pupil's auditory knowledge can make it very difficult to persuade them otherwise.

different times and cultures including music from the British Isles, the Western classical tradition, folk, jazz and popular genres, and by well-known composers and performers (QCA, 1999: p.21)¹⁰.

It can be concluded from this discussion of issues surrounding the suitability of group work that there are more factors involved in collaboration than Vygotsky originally proposed. Of paramount importance is the creation of a suitable social environment for learning. There have also been many issues raised relating to differences between adult/child and peer collaboration. Notably, tasks employing peer work will require adult intervention to provide the feedback that Tudge deems necessary in developing the expert. It is therefore more favourable to view the ZPD as part of a chain when employing it in the classroom:

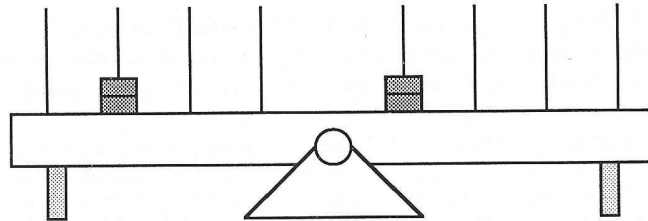


Teachers should be aware that pupils need to be taught how to collaborate and that collaboration, to be successful, needs to be part of the classroom ethos. Finally, it is worthy of note that any attempt to derive educational practices from Vygotskian theory will always be hindered by the problem of translation as there are at least three versions of *Thought and Language* alone which differ substantially in their presentation of theories (Daniels: 2001). Also, the urtext of 1934 is not an accurate representation of Vygotsky's final thoughts as many of the ideas which appear in this volume are from the mid 1920s (Minick: 1985, cited in Daniels: 2001). If Vygotsky had not died so young of tuberculosis many of these problems may possibly have been resolved and the question posed in this essay might have been addressed by him.

¹⁰ This continues through keystages 4 and 5.

Appendix I

A picture of the mathematical beam used by Siegler (1976, 1981) and Tudge (1989), cited in Tudge (1990: p. 162).



The wooden supports used to lock the beam can be seen under each end.

Appendix II

Rules used in Siegler (1976 & 1981) and Tudge's (1989) experiments to assess pupils' level of predicting the working of a mathematical beam.

Rule:	Degree of Confidence	Rule for predicting the working of the balance beam
0		No understanding either of the idea of balance or of what will happen when one side of the beam has more weights. Children using this rule did not participate further.
1	Children using this rule will lack confidence in their prediction.	No understanding of the idea of simple balance but a belief that the beam will tip to the side with the greater number of weights. Children using this rule attend only to the dimension of weight and can therefore predict with confidence all configurations in which one side of the beam has more weights. However, they are uncertain when the number of weights is identical.
2	Children using this rule will have confidence in their prediction.	A belief that the beam will tip to the side with the greater number of weights and that it will balance when the number of weights is equal. Children using this rule attend only to the dimension of weight and can predict with confidence all configurations.
3	Children using this rule will lack confidence in their prediction.	A belief that the beam will tip to the side with the greater number of weights. When the weights are equal, some attention is paid to distance from the fulcrum but not in consistent fashion. For children using this rule, confident predictions can be made when one side of the beam has a greater number of weights; when the number is identical and the distance from the fulcrum is different, there is uncertainty.
4	Children using this rule will have confidence in their prediction.	The variables of distance and weight can be considered simultaneously. Distance is consistently treated as an important variable but only when the number of weights is equal. In other cases, there is a belief that the beam will tip to the side with the greater number of weights. For children using this rule all configurations can be predicted with confidence.
5	Children using this rule will lack confidence in their prediction.	Distance is viewed as an important variable even when the number of weights is different. However, there is no means of ascertaining precisely under which conditions greater distance but fewer weights will overrule lesser distance but more weights; confident predictions cannot be made when children are presented with configurations of this type.
6	Children using this rule will have confidence in their prediction.	An understanding of what will happen in each configuration is gained by multiplying the number of weights by the distance from the fulcrum. All configurations can be predicted with confidence. No children used this rule.

Adapted from Table 6.1 cited in Tudge, 1990: p.161.

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