Chapter 6
Conversations to Support Learning in Technology Education

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Sociocultural Learning Theory and Technology Education

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Sociocultural theory considers the role of action and tools, including language, in the construction of knowledge (Wertsch 1998). It suggests that child cognitive development is dependent on an individual child's responses to cultural and societal influences (Resnick et al. 1991; Wertsch 1998; Wertsch et al. 1995). Sociocultural theory focuses on the role adults and/or more capable peers play in learning, with an emphasis on peer group interactions and collaborative learning (Daniels 1996; Richardson 1998). Smith (1998) suggests that from a sociocultural perspective children gradually come to know and understand the world through participation in their own activities and in communication with others. There is therefore an increasing understanding of the importance that talk plays in cognitive development (Wertsch et al. 1995).

It has long been understood that focussed and considered dialogue between teachers and their students can considerably enhance learning, although much of the dialogue between teachers and students is about management (Davis et al. 1990). There is also a considerable body of knowledge on understanding how conversations between students can enhance learning (Mercer and Littleton 2007) technology then emerges from within a social context and does not occur in isolation.

Technology is inherently socioculturally situated and value laden. Fleer and Jane (1999) argue that within a particular culture taking into consideration the social and cultural needs of the society in which it is developed. Technological knowledge includes the knowledge and understanding required to skilfully and knowledgably undertake holistic technological practice and the ability to critique existing technology and understand its complexity, including how it interacts with humans and the environment (Moreland and Cowie 2007).

Typically, in technology education classes, students are given a technological problem, communicated to them through a given brief from their teacher, for which they have to develop a technological solution. Students then engage in a selection of planned activities to allow them to develop the necessary skills and knowledge to design and possibly develop an appropriate technological solution. They subsequently undertake product development and evaluation by modelling through sketching, detailed drawing and developing three-dimensional models and/or mock-up designs. In most of this activity, oral communication is an essential ingredient whether students are working collaboratively with peers or communicating with key stakeholders. Thus, the focus on this chapter is on the nature and place of talk in the technology classroom.

Talking for Learning

Talk is increasingly recognised as playing an important role in learning. Mercer and Dawes (2008) and Scott (2008) suggest that educational talk is either symmetrical and interactive or asymmetrical and non-interactive. *Symmetrical talk* includes verbal participation by all participants; *asymmetrical talk* involves only one person, typically the teacher or one dominant student. In traditional Western settings, much talk in the classroom is asymmetrical—teachers acting as arbiters of knowledge by leading conversations through transmission of facts, demonstrating, explaining to or correcting students. Symmetrical talk appears more congruous with recent ways of understanding learning in the twenty-first century although asymmetrical talk does still have a place in the classroom, for example, for giving instructions.

In order to understand further types of talk it is helpful to first understand argument. Mercer (2006) suggests that argument is characterised by three specific types of talk. At one end of a continuum of cognitive development is *disputational talk,* which is often asymmetrical talk, then *cumulative talk* and finally *exploratory talk*, both of which are symmetrical.

Disputational talk is characterised by a participant's unwillingness to understand another person's point of view with a constant reassertion of his or her own ideas. Collaborative activity becomes almost impossible as participants strive to have their views adopted. Defensive and uncooperative behaviour typify this type of talk as participants vie for power and control of the discussion.

Within symmetrical talk, as outlined in Table 6.1, cumulative talk occurs when speakers build on each other's contributions and are supportive but uncritical of other contributions. However, shared understandings are not developed and individuals retain ownership of their own understandings. In other words, there is no striving for control in cumulative talk and it does not allow for growth in shared meaning and understanding.

What Mercer (2006) identifies as *exploratory talk*, others call *dialogic thinking* (Alexander 2008) and *inter-thinking* (Mercer 2006). *Intercognitive talk* is a term introduced in this chapter to cluster the ideas represented in these types of talk. It describes conversations in which all participants contribute, learn, value, and build

Table 6.1 Intercognitive talk

Types of talk (How)	Explanation
Interactive and symmetrical	Verbal participation of all participants (Scott 2008). Educational talk when partners in a conversation have equal status (Mercer and Dawes 2008)
(i) Cumulative	Speakers build on each other's contributions, are supportive and uncritical. Shared understandings are not developed, ownership remains (Mercer 2006)
(ii) Intercognitive	Working collaboratively, speakers build on each other's contributions and are supportive and critical in a constructive supportive way. Participants value other contributions. Shared understandings are developed, new joint understanding develops. It includes the following:
	Exploratory: Partners engage critically and constructively in each other's ideas. Agreement is sought as a basis for joint process. Reasoning is visible in talk (Mercer 2006)
	Dialogic: Speakers are encouraged to try out new ideas. Dialogic learning demands both student engagement and intervention through talk. It draws attention from the organisational setting and concentrates on the "quality, dynamics and content of talk" (Alexander 2008, p. 10)
	Inter-thinking: Dynamic interaction of minds, joint co-ordinated intellectual activity (Mercer 2006)

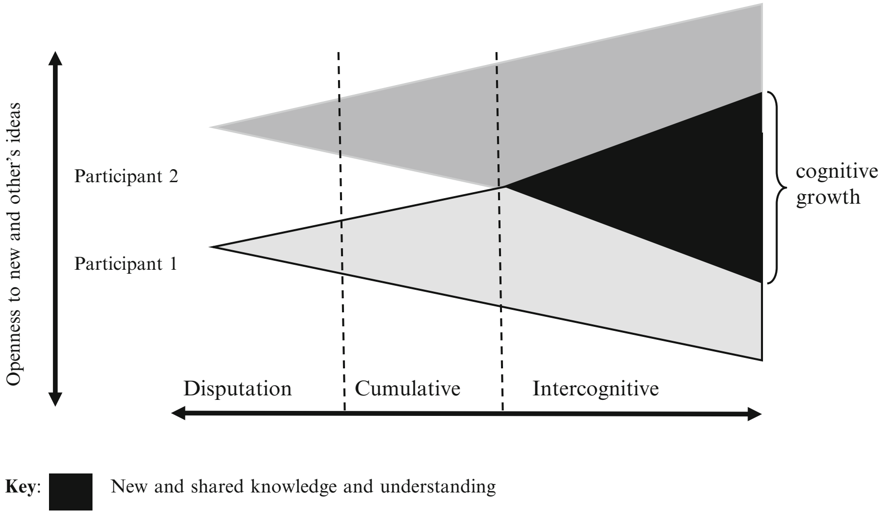

Fig. 6.1 The relationship between shared understanding and types of talk

on each other's contributions. Participants are supportive and constructively critical of each other's contributions, and new joint understanding develops. Opinions offered, if accepted, will sway the subsequent direction of the collective thinking. Prevalence of words such as 'because', 'if', 'I think' and 'why' are used by those who use this type of talk (Mercer 2006) and can therefore be shown to be indicators of intercognitive talk.

Alexander (2008) introduces *dialogic teaching,* a pedagogical approach in which talk is given prominence. He suggests that teachers need to "provide and promote the right kind of talk" (p. 10) to ensure that students learn more effectively and efficiently. Dialogic teaching, in Alexander's view, draws attention the "quality, dynamics and content of talk" (p. 23). Mercer and Littleton (2007) identify another relevant pedagogical approach—*thinking together*—based on *inter-thinking*. Figure 6.1 attempts to show the relationship of new shared understandings generated during these three types of talk.

As understanding about the role and place of talk in learning develops, what learning or cognition actually looks like in a sociocultural setting also needs to be considered before exploring how talk can assist cogitative development in technological literacy through technological practice.

Cognition in the Sociocultural Paradigm

Sociocultural theory, introduced by Marilyn Fleer in Chap. 3, considers the role of action and tools in the construction of knowledge (Wertsch 1998) and deals with the concept that children's cognitive development is dependent on an individual child's responses to cultural and societal influences. The goal of a sociocultural approach to learning is to understand the relationships between human action and mental functioning on the one hand, and the cultural, institutional, and historical context in which this action occurs on the other (Resnick et al. 1991; Wertsch 1998; Wertsch et al. 1995).

Murphy and Hall (2008) suggest that Vygotsky's explanation of fundamental psychological functions, such as perceptions and memory, was that they appear first as elementary functions such as a child mimicking adult behaviour by putting on adult shoes. Later, they appear as higher functions such as putting on their own shoes and understanding that shoes need to be fitting, worn on specific feet, and that different shoes are worn for different occasions. These functions occur through assimilation into sociocultural practices that are undertaken when people live and work together.

Any change in a child's development appears on two planes, first in the social plane or interpsychological functioning and then in a psychological plane or intrapsychological functioning (Murphy and Hall 2008; Rogoff and Lave 1999; Wertsch 1981; Wertsch et al. 1999). Fleer (1995) uses the example of a toddler participating in hand washing after visiting the toilet or before eating to explain these planes:

> This ritual is practised by the child's family and hence is a part of accepted behaviour patterns known to the child. However, the child may not necessarily fully understand what this action means. Vygotsky termed this social behaviour as occurring at an interpsychological level of functioning—at a social level of functioning without understanding. It is when the child understands why she/he is washing her/his hands that the child is said to be operating at an intrapsychological level of functioning. Learning occurs when the child moves from one level of functioning to another. (p. 21)

Vygotsky (1978) called the difference between a child's actual level of cognitive function and development and their potential the Zone of Proximal Development (ZPD). The role of more experienced adults or even peers is to guide children through their ZPD by modelling, talking to and challenging children into new learning. Intercognitive talk is well situated within sociocultural theory because the opposing tendencies or forces which characterise social interaction assist children to develop their own understandings and challenge others' thinking within their conversations. The next section explains how opposing ideas during interaction can assist with cognitive development in children.

Learning Through Interaction

Action and mediation are two fundamental and defining themes running through sociocultural research. Mediation plays an essential role in the basic formulation of the sociocultural paradigm as it provides a link between concrete actions carried out by individuals or groups and the cultural, institutional, and historical setting in which they occur. 'Mediated action' is used very broadly to include all cooperatively and socially organised activities, inventions of shared thought (number systems, language and writing systems) and schemes for cooperative action (shared plans). It also includes a range of social rules, principles for managing recourses and relationships, and technological tools and devices (Richardson 1998). Wertsch et al. (1995) assume that action and the employed mediation exist in complex cultural, institutional and historical real world settings. These settings shape the tools when carrying out action. For example, emergence of writing has allowed the development and understanding of the structure and nature of language well beyond the original need for written communication.

The basic tenet of sociocultural conflict theory—that discrepancy or conflict best sparks cognitive development—is well positioned here. A subset of sociocultural theory, with a focus on the use of language as a tool, sociocultural conflict theory identifies conflict as an essential ingredient for any joint involvement to bring about cognitive change, thus explaining the positioning of intercognitive conversation at the centre of the 'argument' continuum. This suggests that when students' ideas are challenged and have to be defended the process can spark or enhance cognitive development. Doise and Mugny (1984) demonstrated this by showing that children working in pairs solve problems at a more advanced level than those working by themselves, regardless of the ability of the partner. They suggested that when coming up against an alternative point of view (not necessarily the correct one) in the course of joint problem solving, a student is forced to co-ordinate his or her own viewpoint with that of another. The conflict can only be genuinely resolved if cognitive restructuring takes place—in which case, mental change occurs because of social interaction. Thus the social interaction stimulates cognitive development by permitting dyadic (people working in pairs) coordination to facilitate inner coordination. This does not happen through passive presentation of points of view. When students are actively engaged in defending a particular view, and reasoning with other individuals, they experience confrontational socio-cognitive conflict. The subsequent mental restructuring allows each partner to adopt an approach to this specific class of problem that is more advanced than that adopted previously when working as an individual (Lave and Wenger 1996). Students' confidence and ability to defend their point of view can be dependent on their experiences and perceived expertise. Knowledge from their home and community, or their funds of knowledge (González et al. 2005) frequently contributes this.

Funds of Knowledge

Also situated within a sociocultural paradigm, the theory of funds of knowledge draws on the perspective that learning does not just 'happen', but is a social process bound within a wider social context (González et al. 2005). *Funds of knowledge* are the developed bodies of skills and knowledge that are accumulated by a group to ensure that they can function appropriately within their social and community contexts (Lopez 2010). In Fleer's chapter in this volume, the value of funds of knowledge is clearly demonstrated by Willie, as much of what he knows was learned from the practice of his father. In the schooling context, the more teachers know about the home and cultural interests of their students the better informed they will be to maximise learning opportunities and make the most of knowledge and skills already accessible to individual students. When individual cultural knowledge is valued within the classroom, students are possibly more likely to share their knowledge with other students. Clearly talk plays an important part in this sharing, so when funds of knowledge are coupled with intercognitive conversation learning is enhanced for all involved.

The increased value of talk and the idea that students come to school with considerable knowledge and skills signals a change from many traditional education methods of the previous century. In the section below ideas for successful learning in the current century are explored.

Learning for the Future

Gilbert (2005) suggests that new knowledge and skills are needed to enable students to succeed in the twenty-first century and to become life-long learners. Therefore, educational needs and support systems are required to re-focus the education system. Learning in the twenty-first century presents teachers with a daunting challenge of equipping students with skills and knowledge necessary to survive in the information age and beyond. Many new ideas challenge current educational assumptions and schools need to change significantly to meet the new and emerging needs of today's students. For example Claxton (2007) identify the need for greater and different student learning capacities for the twenty-first century, including students being:

- innovative, imaginative and able to problem solve
- curious, entrepreneurial and using initiative
- critical thinkers, analytical and reflective
- collaborative but also independent
- effective communicators
- resilient, determined, focused but adaptable and open-minded

It is essential that the classroom climate encourages and fosters the development of these capacities—that "students' questions are welcomed, discussed and refined, so the disposition to question becomes stronger—more and more robust; broader—more and more evident across different domains; and deeper—more and more flexible and sophisticated" (Claxton 2007, p. 120). To do this, Claxton calls for an epistemic culture change in schools to replace stand-alone courses in thinking skills or 'tricks of the trade' type learning. Aspects of this epistemic culture will include the ways teachers and learners work and talk together; the range of activities and methods they will engage in; the ways students can transfer thinking; and how teachers can model attributes, dispositions, and demeanours appropriate for successful participation in future.

Two recent curriculum developments illustrate this change in thinking. First, in New Zealand *The New Zealand Curriculum* (Ministry of Education 2007) has set a clear direction for teaching and learning in the future. There is a focus on principles such as: high expectations, inclusive bicultural (Māori and non-Māori) practices, cultural diversity, inclusion, understanding learning, community engagement, coherence and future focus, and values such as: excellence, innovation, inquiry and curiosity, diversity, equity, community and participation, ecological sustainability and integrity. The message is that, on its own, content learning in the traditional disciplines or 'subjects' will not produce the necessary skills for today's learners to be effective in the future. Second, in the United States, the *Framework for 21st Century Learning* (Partnership for 21st Century Skills 2009) sets a multifaceted direction for successful teaching and learning that includes core subjects *and* a number of life-long learning skills and dispositions including:

- Twenty-first century themes such as global awareness and financial, economic, business, entrepreneurial, civic, health and environmental literacy
- Twenty-first century learning capacities
- Technological literacy
- Life and career skills—flexibility, adaptability, initiative, self-direction, social and cross-cultural skills, productivity, accountability, leadership, and responsibility
- Twenty-first century education support systems with inclusive and varied assessment practices, instruction, professional development, and learning environments.

Inquiry Learning is one teaching approach that can successfully enable students to perform in ways described above.

Inquiry Learning

Inquiry learning focuses on the facilitation of independent knowledge-based learning and reflects the belief that active involvement in construction of knowledge is essential for effective learning (Kuhlthau et al. 2007; Murdoch 2004). Inquiry learning, currently popular in New Zealand primary schools, is perfectly suited to the implementation and delivery of technology education because of the student-centred, problem-solving approach common to both. In inquiry learning, students are encouraged to construct their knowledge and understandings, enabling them to take ownership of and responsibility for learning—leading to a much broader understanding of the world. Inquiry is very different from 'open' discovery learning as teachers have a major and continuing responsibility to structure a range of activities sequenced to maximise the development of skills and thinking processes of the learners. It involves students engaging in deep learning through the process of self-motivated inquiry and strives towards developing enduring 'big understandings' and 'rich concepts' about the world and how it functions. Students develop and use, through conversation with teachers and peers, higher-order thinking skills at critical points in the learning and development process (Kuhlthau et al. 2007).

Relevance and Implications for Technology

Aspects discussed in the previous sections of this chapter are an integral part of teaching and learning in technology education and situate it with the potential to lead education change as we move into the future. Technology education offers rich contexts for study, social construction of outcomes, connections, cooperation and collaboration with others, and practical engagement in worthwhile and real-world activities (Snape and Fox-Turnbull 2011b).

Technology in a Sociocultural Paradigm

The use of culturally situated tools, including technological artefacts and language, are key factors making sociocultural theory particularly relevant to technology education. Technology is the ‘know how’ and creative process that may utilise tools, resources and systems to solve technological problems and enhance control over the natural and man-made environment with the aim of improving quality of life (Ministry of Education 2007). Consistent with a sociocultural paradigm, technology education sees students undertake authentic technological practice using authentic tools and practices, where learning is contextually driven.

Technology emerges from within a social context and does not occur in isolation from values, beliefs and social life. Technological outcomes are constructed within a particular culture, taking into consideration the social and cultural needs of the society in which they are developed, and those of their developers (Fleer and Jane 1999; Siraj-Blatchford 1997). I suggest that technological solutions developed within the context of the community, in which the needs arise, and those that use local skills, resources and existing technologies, are likely to be more successful than those that are not. The implication for technology education is that students must be cognisant of not only their own, but of their clients’ and stakeholders’ social and cultural needs when undertaking technological practice.

Technology as Inquiry Learning Through Immersion

The bringing together of inquiry learning and technology education facilitates students’ engagement in broad social and cultural considerations. Engaging students in meaningful contexts is essential. So too is the role of the teacher and his/her ability to be able to meet the changing and complex needs of modern teaching and learning. Authentic learning requires teachers to provide students with opportunities to understand their world and take greater responsibility using intrinsic and conative motivation (Riggs and Gholar 2009).

Technology education offers rich contexts for study, social construction of outcomes, connections, cooperation and collaboration with others, and practical engagement in worthwhile and real-world activities and authentic practices (Snape and Fox-Turnbull 2011b). Inquiry learning and technology education therefore have a number of commonalities. They are centred on both process and content, with students taking considerable ownership and responsibility (Murdoch 2004). Technology education involves the construction of technological outcomes; inquiry may similarly require the development of a tangible outcome to solve the identified problem and the development of a means of communicating the inquiry findings. Authentic inquiry practices should also be real to students, their lives, and to situations they may encounter in the future workplace. When undertaken like this, students gain an appreciation of the bigger picture (Blythe 1998; Murdoch 2004), utilise key competencies and values, create and innovate, and work with various media and educational technology. The socially embedded nature of technology integrates a variety of skills, ethics and cross-cultural themes, and technology education should provide students with opportunities to understand and participate in many local, national or global community issues. This involvement integrates a much wider range of authentic learning experiences than is offered in traditional education. Supportive and professionally aware technology teachers guide and facilitate a wide range of skills and processes; thus, their teaching can extend deep into the realm of life-long learning for successful living in the twenty-first century.

The Role of Conversation in Learning Technology

Technology education projects are frequently collaborative. This requires significantly different approaches to work than the desk-confined, textbook and whiteboard techniques of traditional times. Skills required for cooperative and collaborative situations relate closely to skills and competencies identified in the *Framework for 21st Century Learning* (2009) and *The New Zealand Curriculum* (Ministry of Education 2007). The epistemic culture changes recommended by Claxton (2007) and capabilities for effective learning also link very closely to what happens in quality technology education programmes. When students work collaboratively on a single outcome or project in technology education, they must find common ground when they come across differing ideas and solutions. The quality of students' dialogue has significant impact on their ability to work and learn with and from others. Is there a rationale for the importance of dialogue beyond the fact that projects are collaborative?

To advance in technology education, students need to be taught to talk in a manner that will challenge them and their peers and allow growth and development. Although Vygotsky's work did not explicitly discuss the adult-child interactive dialogue, using the concepts of intersubjectivity and alterity can help to make sense of classroom interaction and learning that is taking place. Children's cognitive development is embedded in the context of social relationships and sociocultural tools and practices. The nature of developing technological literacy will involve varied and collaborative conversation, for example, interactions between the expert and the novice during the process of skill development, and conversations with stakeholders involving identification of needs and the presentation and justification of design ideas. When students work in teams to develop a single technological outcome, single solutions frequently have to be found to any issues. Sharing ideas and listening to each other is not enough. In order to identify a common solution or reach common ground in their thinking and move forward in the development of a successful shared outcome, students need to be able to articulate their own thinking and listen to and understand others' perspectives. This will involve intercognitive conversation—compromise and changing and developing their ideas as new material, information and thinking come to light.

A recent study investigating the nature of students' dialogue in technology education identified three distinct themes of conversation: deployment, conduit and knowledge (Fox-Turnbull 2013). The first major theme, deployment, contains conversations that show the deployment of students' existing and recently learned knowledge, either from their home, community and culture, or from knowledge learned at school—from technology education, either earlier learning or from the current topic—and from other disciplines. One significant source of 'deployment' conversations is students' funds of knowledge, rather like Willie, in Chap. 3, deploying knowledge obtained from his father to inform his knowledge and skills using metals. The second major theme, conduit, centres on the implementation of learning strategies and techniques taught, and implemented by teachers and students to manage and facilitate technology practice—thus acting as a conduit for the deployment of knowledge and experiences into contextually relevant technological knowledge and skills. The third major theme, knowledge, refers to conversations that describe the technology knowledge and skills gained during students' technological practice. These conversations are the result of a merger of deployment and conduit into student knowledge and understanding of components, practice and the nature of technology.

All themes have an interconnected relationship rather like a set of cogs. Imagine this set of three interdependent cogs, the first turning the second, which in-turn drives the third, as shown in Fig. 6.2. The increasing size of the cogs signifies cognitive growth in students as they deploy knowledge across fields of learning in a structured and planned manner such as within a purposefully-planned unit of work in technology.

The quality and effectiveness of conversation across all themes, but particularly deployment and knowledge, is enhanced by intercognitive conversation in which students listen to and contribute to each other's learning through quality dialogue.

Technology Education Pedagogy

Technology is positioned to assist students' preparation for life in the current and future technological world. Barlex (2006) suggests that a major educational goal of technology is to teach students the capability to operate effectively and creatively in

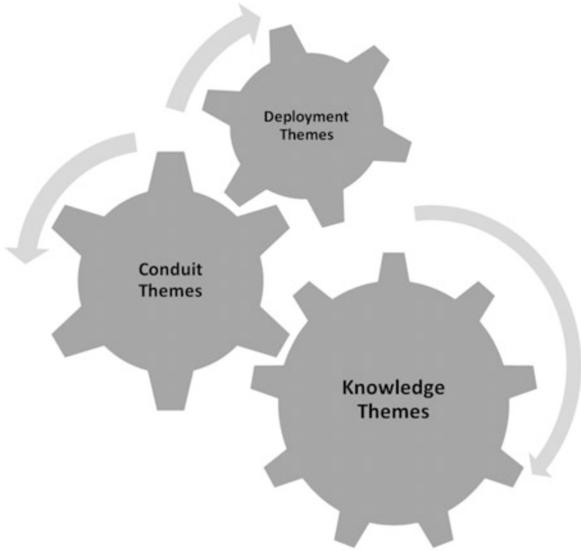

Fig. 6.2 The interconnected nature of conversation themes (Fox-Turnbull 2013)

the made world. It must also prepare students to participate in rapidly changing technologies and to intervene creatively to improve quality of life. Teaching methods and practices must differ considerably to traditional methods used previously. For example, when designing technological outcomes, students have ownership of their design ideas and are often more knowledgeable in aspects of their practice and anyone else, including their teachers. Barlex (2006) states that from a pedagogic viewpoint this is fascinating—it is the pupil who has the knowledge and expertise in this situation; only he/she knows about his/her design.

This shift in learning outcomes requires quite a different role and approach by teachers than previously. Teachers and other experts must facilitate students' learning to enable progression of the intended design and develop knowledge and understanding of the wider social, cultural, ethical and environmental considerations that impact or influence the design. It will include critical reflection and feedback through a range of strategies and activities to motivate, engage, develop and challenge students. This approach involves the giving and receiving of constructive criticism in a supportive environment that is conducive to change and growth.

Dimensions of Authenticity in Technology Education

Authenticity in technology education occurs through specific links to students' context and real technological practice. This definition is predominantly based on connecting students' understanding to meaningful and real-world situations and their involvement in technological practice that is similar to practicing technologists, using authentic tools and processes where possible. Hennessy and Murphy (1999) explain that authentic practice involves situations that are real to the student, their lives, and to situations they may encounter in the future workplace. Activity embedded in authentic technological practice is more likely to produce greater understanding and provide the opportunities for students to identify simulate and relate to the tacit knowledge of technologists. Snape and Fox-Turnbull (2011a) suggest that three dimensions of authenticity enhance technology education: pedagogy and instruction, teachers and learners, and activities. These three dimensions are brought together in complex and rich tasks, interaction with technological communities of practice, using cognitive and metacognitive instruction and thinking, the affective and emotional aspects of learning, active and collaborative participation, and dealing with meaningful problems and issues.

Newmann and Wehlage (1993) base authentic achievement on three criteria: students will construct meaning and produce knowledge, this knowledge is achieved through disciplined inquiry, and students will work toward production of discourse, products, and performances that have value or meaning beyond success in school. Slavkin (2004) identifies that learners function best in environments that are intriguing, multi-sensory and dynamic. Real-world, rich problems provide the opportunity for collaboration and the high-level discourse required for deeper learning. Interactivity between the student and the wider community is fundamental to shifting the focus of learning away from the teacher. Learning should also closely resemble everyday situations, providing students with opportunities to make decisions about the nature, content and pace of their learning (Petraglia 1998).

'Authentic' teachers take responsibility for keeping up-to-date and aware of the variety of possible opportunities that exist for student involvement and engagement (Kreber et al. 2007). Teachers need to integrate aspects of key competencies and values into their subject areas and, as professionals, teachers must ensure that their teaching pays particular attention to what is best for the students and their understanding, to help them make better sense of the world in which they live. Cranton (2001, cited Kreber et al. 2007, p. 34) argues that "the authentic teacher cares about teaching, believes in its value, wants to work well with students, and has a professional respect for students". Kreber et al. state that authentic teachers:

- engage with larger questions of purpose;
- convey how their subject matter matters in the real-world;
- connect learners in substantive authentic conversations or dialogue around significant issues; and
- are guided more by caring for the education of students than by their own self-interest.

Student's ownership and motivation to engage (Murdoch and Hornsby 2003) is necessary if enduring learning is to take place. Riggs and Gholar (2009) focus on the role that students can themselves play to accomplish their dreams and aspirations. They describe this as the conative domain, or conation—the will, drive or determination to achieve a goal. Riggs and Gholar state that "the conative connection focuses on two objectives. Firstly *knowing* what one has to do to achieve a special goal and secondly *doing* what one has to do, intentionally giving one's personal best to achieve a specific goal" (p. x, original emphasis). They identify the fundamental attributes of conation as belief, courage, energy, commitment, conviction and change. Others have referred to similar aspects as self-actualisation, self-efficacy or individuation (Kreber et al. 2007; Tessmer and Richey 1996).

A strong link to intrinsic motivation develops through the challenge, relevance, interest and involvement in the contexts students study:

> The learner must choose to learn and the learner must have enough courage to make the choice to learn. Making the choice to learn is influenced by the learner's perception of herself, her perception of the world around her, her beliefs, how she interprets what she knows or thinks she knows and how she chooses to respond to what she believes (Riggs and Gholar 2009, pp. 46–47)

Empowered students given choice, responsibility and encouragement will mostly flourish and develop the skills and frameworks needed for successful authentic and life-long learning. For these students, motivation, drive and determination will not be problematic as they learn effectively and can successfully relate to connections in the world in which they live.

Reeves et al. (2002) present ten design characteristics of authentic activities identified in literature and suggested they could make a suitable checklist for educators. Such authentic activities:

- have real-world relevance;
- are ill-defined requiring students to define them in order to complete the activity;
- comprise complex tasks to be investigated by students over a sustained period of time;
- provide the opportunity for students to examine the task from different perspectives, using a variety of resources;
- provide the opportunity to collaborate;
- provide the opportunity to reflect;
- can be integrated and applied across different subject areas and lead beyond domain-specific outcomes;
- are seamlessly integrated with assessment;
- create polished products valuable in their own right rather than as preparation for something else; and
- allow competing solutions and diversity of outcome.

Conation in Technology Education

Technology education, through the development of student-driven technological outcomes, is well situated to develop conation within students. By being cognisant of the dimensions of authenticity, and when woven together by four critical aspects of twenty-first century learning, authentic technological practice can be enhanced and teachers should be able to foster high levels of conation in students. The four critical aspects of learning include: rich contexts, social construction, connections

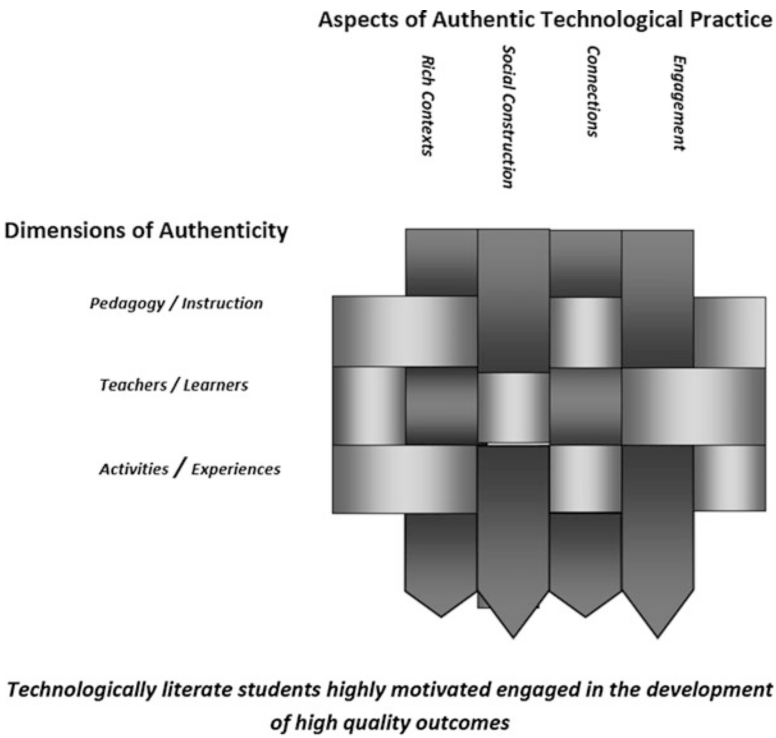

Fig. 6.3 A model of authentic technology for producing quality technological outcomes (Adapted from Snape and Fox-Turnbull 2011a)

and engagement. The development of rich contexts with real, substantive and complex problems enabling significant developmental, intellectual and cognitive growth (Blythe 1998) enables the *social construction* of meaningful *connections* that facilitates an outcome student of *engagement*. The end result is technologically literate students who are highly motivated and engaged in the development of high quality outcomes. This notion is illustrated in Fig. 6.3.

Collaborative Learning in Technology Education

To model collaborative and cooperative technology practice and prepare students for a future in technology, students should be required to work with peers and seek the opinions of experts and stakeholders from the wider community. In addition, they need to be able to alter their own views as new knowledge comes to light. For a group of students to be able to work collaboratively and cooperatively on the development of single technological outcomes, clear communication and ultimately consensus is essential. Students need to be able to discuss, debate, disagree and reason with open minds to solve the technological problems they encounter.

Assessment of Collaborative and Cooperative Learning

Although assessment is covered in detail by Kay Stables in Chap. 7 of this volume, it is worth considering here in the context of multiple students undertaking the development of single technological outcomes. Issues of fairness arise primarily with summative assessment, as with formative assessment identified success criteria and in-depth conversations and observations can assist teachers and students to identify individual current and next step learning. Summative assessment on the other hand is different, especially when students are being graded and / or assessed for external purposes. From my experience students often feel uncomfortable with a single grade being given to a whole group, regardless of individual input and learning because invariably some students contribute more than others do. I call this 'blanket grading' and believe it can and should be avoided. Even when working on single outcomes, no two students will have exactly the same technological practice and I would like to suggest two alternatives to 'blanket grading'.

The first is to assess individually students' reflective practice rather than their actual outcome, by ensuring and subsequently assessing a written, oral or pictorial record of reflections about their technological practice, which will include justification, opinions and thoughts on decisions made. The second approach is for the students to be delegated specific responsibility for different components or aspects within the single outcome. For example, when designing a bicycle one student may take responsibility from the frame, another, the braking and lighting systems and another the gearing system. Separation of areas of responsibility also allows individual assessment of specific aspects of an outcome.

Moving Forward in Teaching Technology—Where to Next?

To learn technology effectively students need to be engaged in contexts that are future focussed, real, substantive, and complex. The contexts must enable significant intellectual and cognitive growth and development. They will relate to the immediate and future worlds of the students and facilitate development of key competencies or dispositions identified as essential for learners. Students must not only be involved in the development of technological outcomes but should also be involved in critique of the technological world. Contexts should offer multiple solutions and include breadth in experiential learning. The learning contexts will promote big understandings about the world in which students learn, connecting threads across a range of contexts—such as sustainability, competition or cyclic resources—and how learning is situated in relation to these (Blythe 1998).

Fleer and Quiňones (2009) state that to understand and to be able to assess children's technological knowledge teachers need to understand the social and cultural context of their learners. The knowledge that students come to school with can enhance their learning and facilitate useful interactions between knowledge found inside and outside the classroom. They suggest that teachers can make more of the learning in their classrooms if they understand that students bring with them knowledge from their families, culture and background and that teachers can legitimise this knowledge through purposeful classroom engagement, “one can create conditions for fruitful interactions between knowledge found inside and outside the classroom” (González et al. 2005, p. 20). This is particularly relevant to technology education as students will often bring knowledge of technological artefacts, systems and processes to their school-based technology practice. Learning starts from a student’s existing knowledge. Having identified this prior knowledge, teachers are able to engage and motivate students by selecting relevant and culturally appropriate technological contexts for learning. When teachers have the mind-set that all students can improve and that students bring their culture and experiences to learning they are in a good position to plan effective, engaging learning (Clarke 2008; Harrison 2009).

Clarity of Learning

Teachers need to become conversant with formative assessment (Black and Wiliam 1998) and the principles of active learning (Newmann and Wehlage 1993), inquiry learning (Darling-Hammond 2008) and collaborative learning (Brown and Thompson 2000) to increase students’ achievement. Clarke (2005) supports the need for students to take a greater role in their learning, through the use of learning intentions, questioning, self and peer assessment, and the use of formative assessment. This involvement increases as students become more aware of the purpose, intent and scope of their learning. Teachers explicitly identifying learning intentions will tend to focus more on actual learning than the activity or experience being used to stimulate student thinking. When appropriate success criteria for the learning are highlighted or co-constructed, the learning will be even greater.

Identification and Articulation of Explicit Learning Outcomes

The identification of clear learning intentions in technology education will inform students which aspect of technological knowledge and skills is to be the focus of learning within any one lesson. Teachers need to consider the knowledge (conceptual, procedural, and societal) and skills (technical and information) students will need to enable relevant learning. Each learning intention should be associated with a planned experience to facilitate that learning. Learning experiences must be purposeful and logically sequenced. This ensures students have enough relevant information about both the context of their study and the necessary technological knowledge and skills to enable the development of their intended outcomes. They should also assist students to understand the societal, environmental and global issues that may affect their decision-making and final designs.

Each learning intention and associated experience usually produces some form of tangible (written, oral, visual, dramatic, graphical) evidence of learning and is able to be used formatively by students and teachers for assessment. They may include such things as posters, charts, interviews, written summaries or reviews, products systems or environment plans, discussion or oral explanations, concept maps, annotated drawings, 2D and 3D planning, functional and prototype models and or the outcome. Evidence that the predetermined learning outcomes have been met can be used formatively or summatively when clear criteria have been identified.

Identification of Context Free Learning

When writing learning intentions for specific technological knowledge and skills it is easy to muddle context and technological learning, so that neither become clear—developing 'mucky brown paint' rather than a clear pool of 'curriculum colour' is a risk, with technological learning buried in 'busy activity' related to the context (Fox-Turnbull 2012). The separation of learning objective and context ensures that students and teacher clearly focus on technological learning. Clarke (2008) suggests separating context from learning intention can have a dramatic effect on teaching and learning. Context—the activity or "vehicle" through which learning occurs—is, however, vitally important. Examples of learning intentions that have been separated from the learning context are given below in Table 6.2. The context-free learning intention, when articulated to students, enables both teachers and students to focus on the key technological concepts and ideas to be taught and subsequently assessed.

Table 6.2 Learning objective with context separated (Compton 2011)

Learning intention Students are learning to.....	Context
Understand the importance making a mock-up has on the quality of a final outcome	School senior ball gown/prom dress
Plan technological practice through the development of a critical path to maximise all team members' use of time	Meals for the elderly living at home
Understand how the physical and functional nature of an outcome impacts on performance	Wooden jigsaw puzzles for an early childhood centre
Explore critical environmental issues and impacts of a commonly used technology	Cell phones
Draw 3D detailed plans of a structure using a suitable software programme	Hutch for a rabbit
Construct quality, safe, user friendly technological outcome for a specific client	Webpage for a local institution/club

Making learning objectives and the separated contexts very clear to students may support them to transfer skills and knowledge from other contexts within and across the curriculum (Clarke 2008). However some learning intentions within any unit of work will be focussed specifically on the context, for example, a historical study of ball gowns or understanding the stages of child development enhanced through doing jigsaw puzzles. Again, the learning intention must be clearly articulated to students so that they may understand the purpose of their learning.

Conclusion

As we move further into the twenty-first century, with the rapid pace of technological change, technology education offers a unique opportunity to develop understanding of the power and place of talk in learning, and the nuances of inquiry learning. This chapter introduces three main sources of talk that contribute to students learning in technology. It also argues that there are numerous similarities between inquiry learning and technology education. I suggest, therefore, that they are perfect partners. Sociocultural theory, inquiry learning and twenty-first century learning all situate the learner at the centre of learning. Quality technology education programmes do the same. Learning well informed by teacher knowledge and theory of authentic learning also offers insight into the potential of collaborative, practically-based curriculum areas such as technology education and, because interaction enhances learning in student-based approaches, the place and role of talk in learning technology is critical to support students' understanding in technology education.

Implications for technology teachers and students are numerous. Teachers of technology are in a critical position to assist students for future success. However, in order to do this, they must let go of control and the need to be the "leading light" or "fountain of all knowledge" in the classroom and empower their students to take control of their own learning. Teachers also need to determine which knowledge and skills need to be taught to whole class groups as 'basics' and which are taught on a need to know basis. When and how to influence and assists students' practice is another important consideration for teachers. Too much intervention too soon may be disempowering for students; insufficient assistance or intervention too late may see students giving up or disengaging.

Students also may need to change. Quality technology education programmes based on widely agreed principles of learning will enable students to drive their own learning. To do this they need to demonstrate conation, be motivated and engaged in their learning, talk to their peers and teachers, be prepared to have their ideas debated, and be open to others' ideas. Learning outside the classroom will play an important role and students need to learn to make connections between multiple aspects of their life and experiences.

Technology education is not only well situated in the curriculum to support students' inquiry learning, but also has the potential to demonstrate the success of an inquiry approach to learning for all teachers and students as they come to grips with recent movements in the understanding of teaching and learning.

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