Classroom Interaction in Technology Education

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Classroom Talk in Technology Education

Wendy Fox-Turnbull

Abstract

This chapter explores classroom interaction in technology education, particularly interactions between students subsequently referred to as inter-student conversation. In authentic technological practice, working collaboratively in teams on the development of products or systems (technological outcome) is common practice, yet frequently in senior secondary schools, students work on individual projects, possibly with the help of a mentor. The summative assessment process is sometimes blamed for this; however, it is critical to encourage all our students to work collaboratively and cooperatively in technology. A vital part of working collaboratively is the ability to talk about and explore possibilities through conversation. This chapter explores the place and nature of conversation in learning technology and suggests the facilitation of inter-student intercognitive conversation as a powerful tool for advancing learning and collaborative practice in technology education.

Keywords

Intercognitive classroom talk • Twenty-first-century learning • Learning power • Funds of knowledge • Context-free learning intentions

Contents

W. Fox-Turnbull (✉)
School of Sciences and Physical Education, University of Canterbury, Christchurch, New Zealand
e-mail: wendy.fox-turnbull@canterbury.ac.nz

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Introduction

This chapter presents a case for teaching students to talk about their thinking and understanding as an integral part of their learning in technology. Recent changes in education promote talk as an effective tool to assist students. This is particularly so in technology given the collaborative nature of technology practice and the inherently social nature of living in the information age, "Technology education offers rich contexts for study, social construction of outcomes, connections cooperation and collaboration" Snape and Fox-Turnbull (2011). Claxton et al. (2013) suggest "building learning power" through active learning which encourages student' ownership of and voice in their own learning. This approach is very much in-line with what has been referred to as "twenty-first-century learning" by Bellanca and Brandt (2010) and Brears et al. (2011) among others.

Alexander (2008) suggests that teachers need to "provide and promote the right kind of talk" (p. 10) in classrooms to ensure that students learn more effectively and efficiently. Mercer and Littleton (2007) discuss a pedagogical approach *Thinking Together* based on "interthinking" which teaches students to use language to think and learn together. Thinking collectively is activity in which knowledge and understanding are reached through conflict, debate, and cooperation. Oral conversation (talk) is a vital component of these processes.

In authentic technological practice, working collaboratively and cooperatively on the development of technological outcomes is common. A vital component of working collaboratively is the ability to explore possibilities through talk. Advancing students' skills, abilities, and understanding about the nature and role talk has on learning enables students to challenge, explain, and question their own and other's thinking, thus advancing their knowledge, understanding, and abilities. In short students can and do learn through talking; however, not all types of classroom talk advance learning.

This chapter focuses on why talk is important and how students can be assisted to develop skills associated with using talk to learn. Understanding the place and value of literally giving students a voice in learning through developing the ability to talk to other students about their own and others' learning, referred to in this chapter as inter-student talk as opposed to teacher-student talk, is vital for preparing students as potential developers, users, and consumers of technology in the decades to come.

Learning for the Current Century

Bellanca and Brandt (2010) suggest that teachers in the twenty-first century face a daunting challenge of equipping students with skills and knowledge necessary to survive in the information age. New knowledge and skills are needed to enable

students' success in becoming lifelong learners in the twenty-first century (Gilbert 2005). Skills supporting innovation, creativity, critical thinking, and problem solving are needed to fulfill the expectations of the new economy (Bellanca and Brandt 2010). Current thinking suggests that it is essential for students to understand the nature of learning including skills, content, processes, values, and competencies to expand their learning capacity. Learning therefore needs to be made explicit. Identifying and sharing clear "learning intentions" to students will sharpen their learning focus and separate the importance of the learning from the context or activity undertaken (Clarke 2014).

Building Learning Power

Claxton et al. (2013) discuss the building of learning power within students through the development of dispositions and attitudes including the building of students' confidence and self-belief in their capabilities. Wagner (2008) and Claxton (2007, p. 117) advocate specific dispositions or capabilities necessary to be effective learners in the twenty-first century. These include engaging in or demonstrating:

- Critical thinking and problem solving, being skeptical and analytical
- Collaboration, learning by influence and also independently
- Agility, adaptability, open-mindedness, flexibility, and creativity
- Reflective, thoughtful, and self-evaluative thinking
- Methodical methods of working
- Resilience, determination, and focus
- Initiative and entrepreneurialism
- Effective oral and written communication
- Accessing and analyzing information
- Curiosity, creativity, and imagination, being adventurous and questioning
- Motivation to build on their products and performances

Claxton (2007) suggests it is essential that a classroom climate is established that will encourage and foster these dispositions or capabilities. He describes this climate as a culture where "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" (p. 120). Inter-student talk is a significant component of many of the above dispositions. For example, it is a vital component of effective oral communication in the transfer of thinking and collaboration. Demonstrating open-mindedness, flexibility, and creativity is also assisted through talk. Reflective and evaluative thinking can also be demonstrated orally and for some students much easier and more effective than when written.

To this end Claxton (2007) suggests that schools and classrooms need to change so that students' capacity for learning is more robust, broad, skilled, and flexible. Summarized below are the eight themes he advocates necessary for change:

1. Language – teachers need to encourage students to think and talk about their learning processes. Conversations require collaborative discussion and reflective thinking.
2. Potentiating activities – student engagement needs to develop a sense of challenge where thinking is hard and frustration or confusion may result.
3. Split-screen thinking – looking to extend students' grasp of content, teachers need to be considering how they challenge students' capacity to learn.
4. Wild topics – topics selected as contexts for learning need to be meaningful, real, relevant, and rich. Students will be challenged through taking greater responsibility and control over their learning and processes. These topics will raise high-quality questions and require substantive discussion and inquiry.
5. Transparency and involvement – students should be encouraged to be part of the change process, understand their role in the change process, and appreciate knowledge creating that is happening
6. Transfer thinking – students should be assisted to see how learning can be transferred to wider real-life contexts in order to better understand their world beyond the school.
7. Progression – learning must be scaffolded to develop understanding in a progressive way, building on previous learning and allowing for students to realize why rather than just be told how to complete a task.
8. Modeling – students need to see learning by seeing the capacity to learn modeled by those around them. Modeling enables students to experience and share learning in a cooperative way with a variety of others such as an expert, mentor, co-learner, or teacher.

Talking about learning is identified as a significant aspect of the themes above and in learning methods. It plays a significant role in the changes Claxton (2007) deems necessary for future learning. For example, talk is a significant and obvious aspect of the transfer thinking and modeling themes. Talk is also explicitly mentioned in the language theme and is an essential part of each of the remaining themes.

The Power of Talk

In ▶ Chap. 38, "Teaching the Language of Technology: Toward a Research Agenda," van Dijk and Hajer promote interaction as critical to the learning process. Oral interaction or talk is a vital component of interaction and a valuable tool for learning (Alexander 2008; Clarke 2014; Hiltunen et al. 2016; Mercer and Littleton 2007; Shields and Edwards 2005). "Language enters life through concrete utterances, and life enters language through concrete utterances as well" (Bakhtin 1981, cited in Gergen 2000, p. 167). Talk between people is a central aspect of cognitive, social, and cultural development (Burr 1995). When referring to talk in this chapter, we refer not to the managerial or social talk common in classrooms but rather talk that can be thought of as oral dialogue because it involves the relating to others. Oral dialogue or effective quality talk requires real engagement with people (Mercer and

Littleton 2007; Shields and Edwards 2005) and is "the discussion that takes place during the course of education activities" (Mercer and Littleton 2007, p. 1).

The place of talk in learning is considerably more important than has been demonstrated in schools in the past. "A sociocultural perspective raises the possibility that educational success and failure may be explained by the quality of educational dialogue, rather than simply by considering the capability of individual students or the skill of their teachers" (Mercer and Littleton 2007, p. 4). When people work together in problem-solving situations, they do much more than just talk together; they "inter-think" (Mercer and Littleton 2007, p. 57) by combining shared understanding, combining their intellects in creative ways often reaching outcomes that are well above the capability of each individual. Problem-solving situations involve a dynamic engagement of ideas with talk as the principle means used to establish a shared understanding, testing solutions and reaching agreement or compromise. Talk that involves thinking together is an important part of life and learning that has long been ignored or actively discouraged in schools (Mercer and Littleton 2007). Molinari and Mameli (2013) in their study of classroom discourse state that lessons that were "open" and "flexible" allowing students space to explore through talk by the sharing of relevant knowledge, challenging of ideas, evaluating evidence, and considering opinions of others while trying to reach agreement in an "equitable manner" (2013, p. 256) proved to be more effective than the more traditional closed lessons in which teachers engage students in a series of questions which they are required to answer with teacher's predetermined responses. Furthermore talk is particularly relevant and valuable in technological practice as designers typically work collaboratively; therefore, "designerly talk" is a natural part of authentic technological practice.

Effective Classroom Talk

It is argued that teachers need to engage in quality classroom talk with students to help them make sense both cognitively and experientially of the world in which they live and work (Clarke 2014; Mercer and Littleton 2007; Shields and Edwards 2005). Engaging in this type of talk involves trust and some degree of relationship between the people involved. It cannot happen if one person treats the other person as an object, but requires people to be treated with "absolute regard" (Sharrat 1991, cited in Shields and Edwards 2005). Mercer and Dawes (2008) suggest that talk in education is either symmetrical or asymmetrical. Scott (2008) suggests classroom talk can be interactive or noninteractive.

Noninteractive or asymmetrical talk is described as the talk between teachers and students where one person takes the lead or has the power. Scott (2008) suggests this person is usually the teacher; however, it could also be a student as within groups when one student dominates conversation and decision making; thus, noninteractive talk is possible within groups of students as well as within teacher-student talk. Hiltunen et al. (2016) note that asymmetrical talk is common in classrooms and frequently typifies teacher – whole class interaction. Mercer and Dawes (2008) also suggest that most talk in the classroom is asymmetrical; teachers often have to act as arbiters of knowledge and therefore act with authority

by leading their conversations through demonstrating and explaining to or correcting students.

Symmetrical or interactive talk occurs when participants are considered to have equal status and control within a conversation such as between students or between a groups of teachers. It is more likely to happen when students are working in pairs or small groups. The literature on symmetrical and interactive classroom talk suggests two subsections: cumulative (Mercer and Dawes 2008) and intercognitive (Fox-Turnbull 2016). Cumulative talk occurs when speakers build on and are supportive but uncritical of each other's contributions. In cumulative talk shared understandings are not developed, and individuals retain ownership of their own understandings. Intercognitive talk, on the other hand, describes talk where participants value and build on each other's contributions. This involves understanding, being supportive, and constructively critical of others' ideas. Intercognitive talk (Fox-Turnbull 2013, 2016) involves participants sharing ideas and understandings to develop new knowledge understandings that neither participant could have done alone.

Intercognitive Talk

Intercognitive talk (Fox-Turnbull 2016) challenges and extends participants' thinking, understanding, knowledge, and skills when working collaboratively, allowing participants to come to a position of new understandings. Intercognitive talk has two distinct categories (Fox-Turnbull 2013). The first, convergent growth conversation (CGC) describes talk when all participants' cognitive growth occurs in the same field or is shared, such as when students research together and co-construct new understandings about their object of research. The second type, divergent growth conversation (DGC), describes conversations when participants develop new understandings but in different fields, such as when teachers talk to their students to assist the students' learning in the context of learning but also learn themselves about how and why students are learning. In other words teachers develop pedagogical content knowledge as the students develop content knowledge. In this chapter intercognitive talk refers to that of CGC rather than DGC.

Alexander (2008), Clarke (2003, 2014), and Mercer and Littleton (2007) discuss the need for teachers to specifically teach intercognitive conversation skills which includes the use of specific ground rules such as accepting others' views, acknowledging others' views may be different to ones' own, being open to understanding how and why others think the way they do, and, most critical of all, be open to change. Teachers play an important role in developing skills and dispositions in students to enable them to be collective thinkers and talkers (Mercer and Littleton 2007). Techniques such as using the statements and questions outlined in the intercognitive talk framework in Table 1 can be taught to students to facilitate their engagement in intercognitive talk.

Undertaking or being involved in intercognitive talk will involve students coming up against ideas that are different to their own. It is part of human nature to consider

Table 1 Intercognitive talk framework – questions and statements to assist intercognitive talk

Questions
What makes you consider this? Why?
What changes would you make to . . .
Which do you think is the better/best? Why?
What if. . .?
If you were XXX (a different person, in a different place or time), how might you think differently?
How might this look in 50/100 years? Why?
What might have been a better choice? Why?
What is the next best alternative? Why?
Statements
I think. . . because. . .
I rate/rank my XXX as YYY because. . .
I hadn't thought of it that way. I could think of it through perspective XXX
My. . . is the same/different to yours because. . .
I would sequence these this way because. . .
I think differently because. . .
Your views would differ from mine because. . .
I came to this understanding because. . .

others' views and aims of any conversation. Doise and Mugny (1984) demonstrated that students working in pairs solved problems at a more advanced level than those working by themselves (regardless of the ability of the partner). Their studies revealed that coming up against an alternative point of view (not necessarily the correct one) during joint problem solving forces the student to coordinate his or her own viewpoint with that of other child. The conflict can only be resolved if cognitive restructuring takes place; therefore, mental change occurs as a result of social interaction and therefore stimulates cognitive development by permitting dyadic (people working in pairs) coordination to facilitate inner coordination (Lave and Wenger 1996). Mercer (2006) also identifies a range of definitions for the term "argument," from heated aggressive debate to rhetorical presentation of ideas. These two examples might be seen as extremes on an "argument continuum" with intercognitive talk situated midway between the two, which might be thought of as "reasoned debate."

Facilitating Intercognitive Talk

In order to get students engaged in intercognitive talk in meaningful ways, there are a number of specific teaching strategies that teachers can use and are particularly useful in technology. Below are three that are particularly useful in the facilitation of inter-student intercognitive talk. These are the identification of context-free learning intentions, facilitation of the deployment of funds of knowledge, and the use the Inquiry learning process to implement student-led technology.

Identification of Context-Free Learning Objectives

Context, the activity or "vehicle" through which learning occurs (Clarke 2005, 2008, 2014) is vitally important. Contexts should come from daily life, thus situating learning authentically (Turnbull 2002). The ways students talk within school differ from that of professionals, for example, an architect would talk about designing buildings in a different way to school students. To assisting students to grow into professional talk, this specificity in genre needs to be made explicit to them. van Dijk and Hajer refer to this as the induction perspective of genre pedagogy within a sociocultural approach.

Working cooperatively and collaboratively throughout all stages of learning including planning, deciding context of study, establishing the intended learning, developing or co-constructing success criteria, and critically engaging in analyzing learning is an excellent way to facilitate intercognitive and potentially professional talk (Clarke 2008, 2014; Fox-Turnbull 2016; Hiltunen et al. 2016). When preparing explicit learning objectives for students, the separation of the learning objective from its context ensures that students and teachers are clearly focused on learning. This facilitates not only teacher clarity when talking to students about their learning but also assists in focusing students when talking to each other about their learning. This can have a dramatic effect on teaching and learning.

Context-free learning objectives, shown in Table 2, assist teachers and students in the development of focused talk and the giving of relevant feedback. Also by making the learning objective and the context separate, students are better able to transfer skills and knowledge through to other contexts within and across curriculum areas (Clarke 2008). Table 2 shows two examples of technology learning intentions firstly muddled with the context and then separated from the context with clearly identified success criteria.

Clarke suggests that the receiving and giving of critical guidance and feedback enhance learning opportunities. Much of this can be performed orally (Black and Wiliam 1998) and can be given by peers when intended learning is explicit and clear success criteria are given as suggested above, to guide or even frame feedback conversations.

Funds of Knowledge

Students come to the classroom with a wealth of experiences and understanding derived from their cultural, home, and community experiences (González et al. 2005). People within any given community draw on a range of sources of knowledge to assist them to make sense of their world. Moje et al. (2004) suggest that utilizing knowledge from a range of sources such as home, church, community, and that learned at school contributes to students' knowledge and understanding, therefore allowing learning and intellectual growth to take place.

While working on the collaborative projects at school, students need to be encouraged to engage in and use home, cultural, and community experiences and

Table 2 Mixed and separated learning intentions

Mixed learning intention and context *The students are learning to…*	Context-free learning intention *The students are learning to…*	Separated context *(Vehicle for learning needs to be authentic to the students)*	Success criteria *(A description of successful learning)*
Draw a prop for the school production	Complete a detailed annotated drawing of their intended outcome	Props for the school production	The drawing will: Show annotations for measurements Identify suitable materials and joining methods to be used Show at least two different views Show an outcome that meets the needs of the client
Write a final brief and recipe for a healthy takeaway food	Write a final brief	Takeaway foods	The brief will: Include information gathered through research and testing Reflect client needs Contain a conceptual statement Contain a detailed list of specifications such as ingredients and measurements

knowledge to advance their own and their peers' understanding and capabilities ultimately advancing the cognitive development for all involved. "It is the responsibility of each teacher to attempt to learn something special about each child they teach" (Lopez 2010, p. 2). The above quote suggests that teachers can impact how, when, and why students share and deployed their funds of knowledge. Classroom climate needs to be conducive to risk taking and facilitate the sharing of such knowledge. Funds of knowledge also draws on sociocultural theory (Lantolf 2010; Wertsch 1998) that suggests that learning does not just take place "just between the ears" but is a social process bound within a wider social context. Students have knowledge given to them through their family and cultural life experiences. Engagement in intercognitive talk is more likely to occur when students are using personal funds of knowledge (González et al. 2005) to contribute to understanding because relevant knowledge and experiences brought to a specific situation from home and the community enable new connections to be made. It also has the added bonus of giving status to the student who contributed within that specific conversation or when solving a related problem.

The value of the contribution of students' funds of knowledge to technology was exemplified in a study recently undertaken. The 10- and 6-year-old students were required to design and build props for their school production. During the initial

stages, the students needed to understand the character and function of props. One very quiet 6 year old was able to contribute significantly to her classmates' understanding as she had experienced going to the theater as a part of her family's recreational activities and seen props in action. Two 10-year-olds were able to contribute both knowledge and skills when working with wood collaboratively as one father worked in the construction industry and the other had built a tree house with his children. Finally another 6 year old assisted his group by sharing collaborative and cooperating strategies his father taught at home to improve harmony between three active brothers (Fox-Turnbull 2013).

Inquiry Learning

To ensure a high level on engagement from a full range of children in any class, each who have a range of funds of knowledge to draw from, teachers need to maximize the use of integration and authentic contexts for learning. Inquiry learning involves students in developing deep learning through the process of self-motivated inquiry that strives toward development of "big understandings" and "rich concepts" about the world (Murdoch 2004) and how it functions (Blythe 1998). It encompasses a wide range of skills and processes in active learning leading to a much broader understanding of the world the students are part of (Kuhlthau et al. 2007). When undertaking inquiry learning, students are encouraged to construct their knowledge and understandings within their own cultural settings. This is a process that enables students to take greater ownership of and responsibility for their learning. One type of inquiry learning focusing on the facilitation of independent learning is guided inquiry (Kuhlthau et al. 2007).

Guided inquiry reflects the belief that active involvement in construction of knowledge is essential for effective learning (Kuhlthau et al. 2007; Murdoch 2004). Guided inquiry proceeds through a number of teaching and learning phases. It is very different from "open" discovery learning in that the teachers have a major responsibility to structure a range of activities sequenced to maximize the development of skills and thinking processes of the learners in the early stages of each inquiry. Guided inquiry uses a wide range of teaching approaches from teachers' exposition to independent student research (Murdoch 2004). All inquiry learning facilitates integration of knowledge construction within the "third space" (Moje et al. 2004). The third space can be thought of as merged knowledges from peoples' homes, peer networks and communities, and funds of knowledge – the "first space" with discourses encountered at school and other more formalized institutions such as work – the "second space." Figure 1 illustrates this in the context of students designing and developing props for their school production. Some students brought from home knowledge of theater and the role of props play in the stage production. At school in technology, they learned the design process and how and why to model their design ideas, and in maths they learned to measure. By intersecting these two spaces, students were enabled to create the quality props needed.

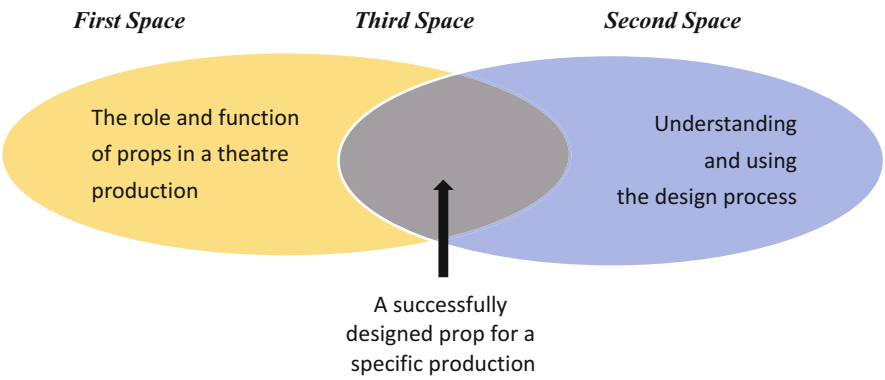

Fig. 1 The three "spaces" illustrated through technology

Context-free learning intentions, funds of knowledge, and inquiry learning are described and illustrated above. Each is a useful way to facilitate inter-student talk in technology. Classroom talk is perhaps more important in technology than some other curriculum areas because of its practical and frequently collaborative nature and the fact that when undertaken using authentic contexts interaction with clients and other stakeholders is an integral part of the process.

A Case for Talking Technology

When participating in technology education, students require a range of academic, social, and physical skills in order for them to collaboratively develop technological solutions to meet identified needs or opportunities (Ministry of Education 1995). It is the physical, hands-on nature of technology education that makes developing "third space" understanding explicit to students by emphasizing the merger of the school and community or social spaces in which they and others interact (Moje et al. 2004). Much sharing of knowledge in collaborative projects occurs through inter-student talk. However talk does not only enhance students' learning in technology. The case for "talking technology" is twofold. The first is that technology practice is enhanced by talk as suggested above. The second is that technology practice is an excellent tool for assisting students in developing skills in talking and understanding of the value intercognitive talk particularly plays in learning. Table 3 gives an overview of learning in both categories across the three strategies mentioned above. Each is explained in more detail in the following two sections.

Talk to Enhance Technology

When undertaking technological practice, students share, discuss, debate, and draw from their funds of knowledge to engage with their peers to design technological

Table 3 Overview of the three strategies outlining technology talk

Intercognitive talk		
Strategies	Talk to enhance learning in technology (teacher strategies)	Technology education enhancing talk (student talk)
Context-free learning intentions with specific success criteria	Asking questions and making statements to describe learning within each lesson	Learning intentions and success criteria assist students to focus talk on learning achieved or the degree of which learning is achieved
Funds of knowledge	Culturally based skills and knowledge contribute to students' technology practice and outcomes	Understanding how culturally based skills and knowledge assist their own and others' learning which positively influences students' self-esteem
Guided inquiry approach	Working collaboratively and cooperatively on authentic technological inquiry-based projects. Compromise and being open to others' view are essential skills for success	Developing awareness of the intense satisfaction and sense of achievement of using talk to solve problems in a group when individuals are unable to progress alone

outcomes. Knowledge and skills learned by students come from two aspects. The first is that of the context within which the project is situated, such as school production props in the example mentioned above, and is known as specific content knowledge. The second is knowledge of technology and technology practice, known as generic technology knowledge. Generic technology knowledge holds the key to ensuring learning from one project is transferrable to other projects. Table 4 outlines how context-free learning intentions (Table 2) can be overlaid in the intercognitive framework (Table 1). It can be seen that the context-free learning intentions and questions are applicable to any number of technology projects. Within the potential statements, the context, although present, could easily be changed.

Students' funds of knowledge are a valuable source of practical and theoretical knowledge in technology as students assist their own and others' practice by volunteering culturally based skills and knowledge only they may have experienced. Talking is central to this process as it is immediate and less onerous than other forms of sharing for many students especially those who find writing and/or drawing challenging. It is particularly useful as students frequently work in small groups and with a range of people including peers and potential stakeholders; thus, in any one project, a number of "funds of knowledge" may contribute, and with the smaller groups, everyone's voice is likely to be heard.

During technology practice students are highly likely to experience points of view both similar and different to their own, ultimately leading to new and varied understandings especially as they come to grips with the reality of collaboratively developing a single technological outcome. This is a typical scenario in guided inquiry when students are researching and investigating technologies to develop design ideas for a single "group-produced" outcome. Reasoned debate is a normal part of this process. It is the experience of the author that the quality of group

Table 4 Using context-free learning intentions and success criteria to evaluate outcomes

We are learning to draw our intended outcome *Context – props for the school production*		
Success criteria	Questions to be asked	Potential sample statements
1. Show annotations for measurements	What made you consider these measurements when the real ones are smaller?	The measurements we have selected are slightly bigger than an original because I think on the stage, the prop needs to be clearly visible and recognizable to the audience
2. Identify suitable materials and joining methods to be used	How do you justify the materials you have selected?	The materials I have selected are wood and corflute plastic because both are durable, readily available, and cheap and I can work with them
3. Show at least two different views	What if the views you drew were from other aspects than the ones you have selected? How might this add value to your plan?	I came to the understanding that I needed two views on my plan because if I was making this prop I would need to know what all the sides look like and the shape it is from above
4. Meets the needs of the client	Which design best meets the needs of the client? Why is this?	I think this plan of my prop is better than the one done by X group because my designs clearly state how I have meet the needs of our stakeholders

collaboration and communication also impacts on the quality of the technological outcome; however, there is acknowledgment that this is an area that needs further investigation.

Technology Enhancing Talk

Technology education has an emphasis on design, innovation, creativity, entrepreneurialism, cooperation, and societal integration, often through practical involvement. It therefore seems well placed to facilitate learning for the future across all walks of life both in and out of formal schooling. The multidisciplinary nature and holistic approach of technology allows students to make meaningful connections. Current learning theory tells us learning must be made explicit to students (Bellanca and Brandt 2010; Clarke 2008; Claxton et al. 2013). Shared context-free learning intentions do this. In technology students design and develop technological outcomes to meet authentic needs and opportunities. They know what they are designing and why. Having an authentic context engages and motivates students as it enables them to see reason behind what they are learning. Context-free learning intentions assist students' ability to transfer skills and knowledge across disciplines. With assistance from their teachers, students can be shown the role talk plays in

developing their thinking and learning process not only in technology but in all areas of life.

Technology will also assist students, especially for those in minority groups, in understanding the role and value of their funds of knowledge and how they contribute to their own and peers' learning. When contributing in this manner, students receive status within the conversation and most importantly assist in the development of new joint understandings which enable their group to move forward in their practices in technology. Being able to make valuable contributions to others' learning assists in the building of self-esteem. Increased self-esteem has the potential to improve achievement (Clarke et al. 2003). Technology offers real and varied opportunities for all students to contribute regardless of culture, ethnicity, gender, or ability by having input from a range of practical, academic, and social skills and knowledge into their collaborative technology practice.

When working on an inquiry-based project collaboratively with peers to develop a single technological outcome, a single solution has to be found for all problems that arise during the process. Students need to reach agreement about the nature of their intended final outcome. During this process just sharing ideas and listening to each other are not enough. When differences occur students need to move and/or merge their understandings and knowledge with that of others. Technology therefore offers a perfect opportunity to advance understanding in the role of talk in learning. Through intercognitive talk students will be challenged, grow, and develop together with their peers. The advantage of using intercognitive talk is clearly illustrated. Students can then be taught that these strategies may apply to other learning situations within which they find themselves. By being challenged and open to change, students learn that they can and do advance their thinking and understanding through talk.

Conclusion and Future Directions

This chapter has focused on the place and value of oral interaction (talk) in the classroom. It has also presented a number of strategies that are well situated to enhance students' learning through intercognitive talk in technology. It offers a framework that teachers and researchers alike can use with students to increase the quality of talk in technology and suggests ways in which talking in technology can assist learning in other areas. To conclude the chapter opens a number of opportunities for potential research in the field of technology education.

Today many students do much of their informal interaction with peers in the form of online chat (texts, tweets, etc.). This chapter does not consider online "talk-like" interaction, but it does raise the question as to whether this type of online chat is just as effective as the face-to-face interaction suggested in the chapter. What are students' attitudes toward a more formal conversation framework being suggested for this less formal medium of communication with peers? Would talk lose its effectiveness and would students resist communicating in this way if it suddenly becomes part of their "school work?"

Mentioned earlier in the chapter is the anecdotal evidence from the author that suggests, that there is a relationship between the quality of the conversations and the quality of the technology outcomes small groups of students produce. This is another area in the field of interaction in technology that needs investigation. Just how valuable is quality talk in technology? What impact does intercognitive talk have on the quality of technology outcomes? Why is this so?

Finally understanding the place and value of talk in the classroom and the role plays on students' learning is changing thinking and practice in teaching. Research into inquiry learning and the role of talk plays in learning technology has challenged prior beliefs about effective learning and has turned many teaching practices upside down. Rather than being quiet places of learning, classrooms should now be full of learning-focused talk. Students should be taught how to talk and challenge others' ideas while accepting and understanding that all ideas have a place in the learning process. Independent inquiry learning plays a significant part in teaching technology education and will continue to do so in the future.

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