Online reflections about tinkering in early childhood: A socio-cultural analysis

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Abstract

Science education research predominantly shows that students improve their scientific understandings when they tinker (or pull apart) tools and simple household machines. In this study, the qualitative data collected took the form of online journal entries by final year, female, primary teacher trainees, who reflected upon their early childhood experiences of ‘tinkering’. Data analysis, from a socio-cultural perspective, shows that many of these fledgling teachers of technology face similar issues found for young

girls. Results of the study indicate that teaching technology is as much about winning hearts as educating minds. These personal reflections on very deep responses to technology must be an important part of preparing teachers to deal with young children's learning and responses.

Introduction to the tinkering and girls debate

This article contributes to the 'tinkering for girls' debate by reporting on a study that identified how female primary teacher trainees felt about their tinkering experiences in early childhood. Socio-cultural theory provides a potentially useful perspective on the gender issues surrounding the debate.

Science educators generally agree that 'tinkering' (the process of dismantling technological artefacts) is practical activity that engages students and potentially enhances their understanding of science concepts. Tinkering provides opportunities for students to discover how the mechanisms in tools, gadgets and simple machines work. Suitable artefacts for students to tinker with include torches, water taps, door locks, telephones and worn out household appliances such as toasters and irons. Fleer and Jane (1999, 2004) recognise that students have much to gain when they are encouraged to tinker with everyday technological products. However, some research shows tinkering to be less appropriate for very young girls, who think that deliberately pulling apart an object is being destructive.

A literature search located several examples of practice by science teachers who implement tinkering activities with the specific aim of fostering participation and problem-solving ability of both girls and boys. One such teacher was Mary Budd Rowe, who challenged her primary class to solve a physical science problem. She observed pairs of children as they worked experimentally to find solutions to the problem, and noted that initially the girls appeared less successful in their efforts compared to the boys. She attributed this difference to the girls being less familiar with using the necessary tools. One strategy she tried was to provide opportunities for the children to tinker with the tools prior to setting the class another problem. This time she noticed a difference in the girls' performance because they, like the boys, also found timely solutions (Butler Kahle, 2003). Another example is the work of the McClintock collective (1988), a group of female science educators in Australia, who

as pioneers generated innovative, gender-inclusive science curriculum materials. The collective strongly advocated providing girls with opportunities to tinker, because they were convinced that tinkering increases girls' participation in science. A third example involves Norwegian teachers, who try to equalize children's experiences by providing tinkering time in the classroom. As the girls and boys tinker, they become familiar with the materials and equipment, including the tools needed to solve problems in future lessons.

While these examples are supportive of tinkering for girls, the issue of girls and tinkering is not clear-cut. Fleer (1990) argues against the idea of tinkering at the early childhood level. In one study she analysed the conversations of a group of Year 2/3 girls as they dismantled a clock. Instead of trying to understand how the clock worked, the girls focussed on identifying suitable parts for making a robot. They happily tinkered with the clock for the purpose of finding parts to be used later in constructing their robot. In contrast, observations of a similar age group of boys revealed that they eagerly pulled the clock apart by unscrewing each component. Then they moved on to another tinkering task: dismantling a radio. Fleer also noticed a difference in language between the two groups. The girls operated from a constructive framework, whereas the boys approached the task from a destructive framework, drawing on their previous experiences of tinkering in their home environment.

A similar gender difference was evident when 25 pre-school children participated in an activity of their own choosing. The boys participated more in dismantling artefacts on the tinkering table than the girls. Observations showed that most girls avoided the tinkering table entirely, or merely glanced at what was happening there, and immediately moved on to participate in a different type of activity.

Socio-cultural theory

For more than two decades, constructivism has been the dominant view of learning held by science educators. Constructivism is a particular view of learning, whereby learners actively generate meaning from experience. Over the years there have been further developments in different domains, such as radical constructivism (popular in mathematics education) and social constructivism (with supporters in science education), but the focus has remained on the individual acquiring knowledge. In

recent years there has been a paradigm shift, from learner-centred constructivism to socio-cultural theory. This shift is particularly evident in research in the field of early childhood, where a socio-cultural perspective has been strongly embraced by leading early childhood educators such as Fleer and Robbins (2003). However, as Fleer and Richardson (2004) found in their study, early childhood teachers require extensive time if they are to change from an individualistic approach to a socio-cultural approach.

From a socio-cultural perspective, development is viewed as a cultural process that involves people's changing participation in the cultural activities of their communities (Rogoff, 2003). In socio-cultural theory (derived from research by Vygotsky and others), learning is more complex than merely the discovery of knowledge by an individual. "Learning is seen as a function of ongoing transformation of roles and understanding in the sociocultural activities in which one participates" (Rogoff, 1994, p. 210). Here 'Transformation of participation' means that knowledge is continually enacted through human participation in a changing environment (Rogoff, Matusov & White, 1996). "People change through transforming their participation in sociocultural activities - in which both the individual and the rest of the world are active" (Rogoff, 1997, p. 266).

Context for the study

The study reported in this article was carried out in a metropolitan campus of a university in Melbourne, in the state of Victoria, Australia. All primary teacher trainees are required to participate in a core unit in technology education. This unit is not organised as a series of formal lectures, but instead, consists of two-hour tutorials, weekly for one semester. In these face-to-face tutorials, the trainees participate in hands-on science and technology activities in small groups.

One assessment task was a 'Community project' that the trainees carried out in their own time. The task was to 'design and make a technological product' to meet a real need, or solve a problem of a client in the community. Once the product was completed, the client evaluated how well the product worked. Another requirement was that each week the trainees were expected to read specific research articles on science and technology education and chapters of the text (Fleer & Jane, 1999). After

reflecting on the readings and their involvement in the science and technology activities in tutorials, they wrote responses as online journal entries that were accessible to others studying the unit. The lecturer intended that this process of reflection would encourage the trainees to make links between what they learnt in tutorials and their prior experiences in science and technology.

One tutorial focussed on tinkering, and the lecturer began the session by brainstorming ideas about how to dismantle a 'Dustbuster' (a hand held electrical dust collector). This simple machine is used in many Australian homes (Jane, 2000). The lecturer then introduced the 'Tinkering with toys' activity (Figure 1) and encouraged pairs of trainees to dismantle a range of toys to see how they worked. After examining all the constituent parts, the trainees were required to put the dismantled toys back together again. This structured task involved the 'Predict, Explore, Record, Evaluate' strategy.

Predict:	First, using only one coloured pencil, draw a sketch of the toy from the outside, and then what you think it might look like inside. Name all the parts and materials that you know.
Explore:	Next, pick up the toy and try to pull it apart, making sure that you lay the parts out in order, because you have to put it back together again. This ‘layout activity' will help you succeed. Look at all the different parts and find out their names and functions. Observe all the materials that have been used to make the toy.
Record:	Now, using a different coloured pencil, draw what you have found out about the toy. Name all the parts, including the materials they are made of, and describe the function of each part.
Evaluate:	Lastly, compare the different colours to check what you have found out. Write down what you have learnt by doing this activity.

Figure 1. 'Tinkering with toys' activity (Fleer & Jane, 2004, p. 96)

The 'tinkering with toys' activity became the catalyst for many trainees to reflect on their early childhood experiences of tinkering and consequently write about these in their online journal entries.

Study design

The sample for the study consisted of 100 female primary teacher trainees, who were enrolled in a core Primary Technology Education unit in the final year of a Bachelor of Education course. As this was an undergraduate course, the majority of trainees were in their early twenties. In addition there was a considerable number of mature age students, who transferred from other tertiary courses or were mothers returning to study. The trainees had a range of socio-economic backgrounds, and most were HECS places, with only a few being fee-paying students.

The unit was organised as face-to-face tutorials. In addition to attending tutorials the trainees used Information and Communication Technologies to place journal entries electronically on WebCT to share their reflections with their peers. In this way online discussions could develop around these e-journal entries, with a sharing of viewpoints that linked theory (readings and text) and practice (hands-on activities in tutorials and prior experiences in their home environment).

The data and analysis from a socio-cultural perspective

The study design described above, generated qualitative data in the form of e-journal entries that were readily accessed from the online discussion section of WebCT. Many trainees reflected on their involvement in the 'Tinkering with toys' activity (Figure 1) and wrote e-journal entries that contained vivid descriptions of their feelings about tinkering when they were young girls. The data so obtained were analysed from a socio-cultural perspective derived from the work of Vygtosky (1987) who emphasised the importance of children's life experiences and natural conversational contexts.

As I read the data I took notice of the activities that these trainees participated in as young girls in their home environment. I attended to the significant relationships, artefacts, actions and histories within those contexts and activities. Rogoff's (1998) three foci - the personal (or individual), interpersonal and community/institutional (or groups of people) - became a useful tool in the process of analysing participation in these activities. "Using personal, interpersonal and community/institutional planes of analysis involves focusing on one plane, but still using background information from

the other planes, as if with different lenses" (Rogoff, 1998, p. 688). These planes of socio-cultural analysis are inseparable, mutual, and show the individual's participation or involvement in the cultural context. The different foci enabled me to consider various factors, such as shared understandings and interpersonal relationships that support or structure these understandings. I used the community/institutional lens to highlight specific community constructions of science and technology, and the value that is placed on science within that community. With one focus foregrounded, the others in the background (yet still part of the analysis), the multiple pathways to learning within the community became transparent. "Foregrounding one plane of focus still involves the participation of the backgrounded planes of focus" (Rogoff 1995, p. 140).

Socio-cultural theory, in particular Rogoff's (1998) interlocking planes related to activity, formed a helpful framework to analyse the journal entries. A *personal plane of analysis* enabled me to focus on how the trainees were changed by the tinkering process. I concentrated on the role of the individual trainee, while keeping the interpersonal and community planes in the background. The *interpersonal plane of analysis* allowed me to focus on the social context and how the family members communicated with each other and the trainee. Furthermore the interpersonal process and the social context were considered. The *community/institutional plane of analysis* allowed me to focus on the trainees' participation with others in culturally organised activities and the cultural tools used. Rogoff (2003, p. 182) recognises that "from a sociocultural perspective, it is no surprise that children, as they observe and participate in the gendered roles of their communities, are quick to take them on." I did not prioritise any particular plane, nor considered it in isolation from the other planes of analysis. I analysed the e-journal entries by looking for patterns in the socio-cultural activities mentioned, by foregrounding in turn, the personal, interpersonal, community aspects associated with the tinkering activities, while simultaneously holding the other aspects in the background, yet taking all three aspects into account.

Discussion of study findings: categories of influence

In the present study, I analysed the e-journals by reading them in such a way as to value the trainees' subjective experiences and self-perceptions. In these e-journals the

trainees identified 'categories of influence' that affected how they viewed themselves in relation to tinkering activities in the context of their childhood. They identified several categories of influence - innate, learned and role modelled - relating to their early childhood tinkering experiences.

What comes through strongly in the data is the personal nature of the responses to tinkering. It has to do with the way the trainees position themselves as people in relation to technology, which is an ontological question about the way they see the world. The question of what frames this - whether it is innate, or learnt through experience and role modelling, - is raised in the e-journal entries. These online responses showed that parents were role models for many of the trainees in their early years. They were influenced by other family members' attitudes towards tinkering. They recalled their parents' interest in, or indifference to, girls tinkering in the home environment. I have selected five examples that are 'Representative' of the many e-journal entries. Following each e-journal entry, I discuss the response using Rogoff's planes of analysis.

> ***Female teacher trainee 1:*** *I've asked myself a number of times why at a young age, I'd get halfway through pulling apart a telephone with my brothers and then just stop while they continued to happily dissect! I remember I would get quite frustrated when I couldn't put something back together that I'd pulled apart. I'd often hide all the bits and pieces so that I wouldn't have to look at them and neither would anyone else!*
>
> *I think the desire to tinker has a lot to do with modelling. Perhaps it's not the only reason, but I think it is a predominant one. I often watched my Dad tinker away in our garage, every weekend really, but cannot recall Mum ever having done it. Maybe my reluctance to pull things apart was associated with the idea that it's 'destructive' and perhaps it was relayed to me (albeit possibly unintentionally) that a woman's duty was to nurture and heal, not destroy!*
>
> *Despite all this, I too found the exercise on tinkering liberating. I think it was because a person who was over us gave us permission to do it, but also because we knew we had to put the toy back together as well so we weren't really destroying it. If the latter is put into practice in technology classes, then it's very likely that girls will feel much more at ease to participate in tinkering*

sessions. Also, drawing attention to occupations where women 'tinker' might be beneficial modelling for students. (Just on the side do you know I wasn't allowed to have Barbies? Mum thought they promoted an unrealistic and negative body image...)

Using the 'personal lens' of analysis, trainee 1 reflects on her childhood experiences and recognises her feeling of frustration associated with her tinkering attempts. Her reflections are consistent with the research that cautions teachers to rethink the appropriateness of tinkering experiences for very young girls. The action of dismantling products can be viewed as deliberately breaking them. In the case of trainee 1, her reluctance to tinker arose from her perception that engaging in such a task is being destructive.

The 'interpersonal lens' shows that she contrasts her lack of persistence, with her brothers' continued interest in pulling things apart. She considers past interpersonal interactions and identifies stereotypic role models within her family: females are caring and do not break things.

A 'community/institutional lens' shows that she recognises the benefits of providing tinkering experiences for girls in the classroom. Moreover she takes this idea further, by suggesting that teachers should inform students of vocations having a tinkering component as being suitable careers for girls.

Female teacher trainee 2: *I found Elaine's response to tinkering very similar to my own. I too agree that tinkering is a modelled behaviour. As a child, I grew up in a family consisting of three females and two males. The different gender roles were identified in many ways, specifically through the daily routines demonstrated in the home. My sister and I were encouraged to assist and observe my mother engaging in tasks such as cooking and cleaning. However, my brother and father would regularly participate in activities that required an examination of materials. So, tinkering with toys, cars, and so on, was a modelled and learned behaviour.*

Again, similar to Elaine, I was unsure of myself as a technological learner when Norm introduced the concept of tinkering in the first tutorial. I was embarrassed when I couldn't identify certain parts of a tap. However, I was

also shocked to see that I wasn't alone in my thinking, or lack of! During the last tutorial, I felt much more comfortable exploring the different structures of objects. I realise that although I wasn't exposed to tinkering during my childhood, I am, and will remain to be an investigative learner.

Using a 'personal plane' of analysis, trainee 2 categorises herself as a person who learns by investigating. In the tutorial tinkering with toys activity, she felt unsure of herself, and ill at ease due to her inability to name the components of a household tap that she used regularly in her home environment.

An 'interpersonal plane' of analysis reveals that she was surprised to find out that others in her tutorial group also lacked an understanding of how some things work. This lens also shows that as a child she was restricted by the interpersonal interactions in her family, where tinkering was considered a male activity. This is consistent with Rogoff's (2003, p. 74) view that "gender differences appear to be nurtured by differences in the tasks assigned".

Female teacher trainee 3: *In response to Jean and her tinkering question as to whether it is learned, innate or modelled, when I was younger every gadget that broke mum would give to me to pull apart and have a fiddle and an explore. I would then attempt to put it back together again. I am female, my dad was not interested in these kinds of activities, and my brother was too busy playing war and my sister was playing house with the neighbours. The tinkering that I did was not modelled and I did not have any real contact with anyone who would have taught me. (I asked my mum and she agreed).*

When I was sitting in class the other day and was 'allowed' to pull apart a toy the interest was still there. I found it quite amazing that so few people had actually 'tinkered' as a child. I did not develop any great skills from my five years of tinkering and was interested in the fact that I was still unable to put a basic toy back together after being let loose on it.

My next-door neighbour (also female) and I would tinker for hours on things we found in her garage/shed/under her house. Neither of us had a model to observe and copy; we both chose tinkering instead of dolls. My experience was not a learned action nor was it modelled.

> ***Female teacher trainee 4:*** *At home I can remember participating in more tinkering. I was a very curious child, always wanting to know how things worked, similar to many children now. I would ask mum, "How does a toy work?" and mum being mum and knowing everything would give me an answer. But that didn't satisfy my curiosity, out would come the tools, and apart would come the toys (or sometimes more expensive household appliances). I would run in, "Look mum, it makes this noise because of this!" or "This is how it moves!" I was so interested in how things worked that I would spend the weekends in the shed with Dad while he pulled apart his motorbike and put it back together. "That's this Dad? What does it do?" etc. was always being asked by myself. It drove Dad up the wall, but it started satisfying my desire to pull things apart to see how they worked.*

When applying the 'personal plane' of analysis, in contrast to trainees 1 and 2, the childhood experiences of trainees 3 and 4 reveal that their interest in tinkering comes from their individuality and seems to be innate. These two examples of participation show that this interest in tinkering did not diminish with maturity.

The 'interpersonal plane' of analysis shows that for trainee 3 the social interactions involving tinkering with family members included her mother, whose continual encouragement for her to tinker acted like a catalyst. As a child she also spent a lot of time with her girlfriend next door, tinkering in the shed, garage or under the house.

A 'community lens' shows the 'shed' an Australian cultural icon, was also the place where trainee 4 questioned her father about how things work, while she watched him fix his motorbike.

> ***Female teacher trainee 5:*** *I also agree that tinkering can be a valuable learning tool in a technology classroom, but have some issues. I think that as an introductory tool it has potential, only if students are prepared to then investigate what they have found in the appliances. Also from participating in the lesson on tinkering I was too scared by the prospect of having to put the object back together to actually pull it apart! This was the response of some others in my group who were too scared of breaking the objects. This is just a result of how I was raised - not to touch things that are not mine, and to be careful with other's things.*

There is also the feeling that I am not capable of putting things back together, even simple mechanics, as I have very little experience in the past and do not like doing things that I'm not good at.

The 'personal plane' of analysis shows that trainee 5 believes her current fear of tinkering stems from her childhood experiences. She feels that not having tinkered as a young girl, has contributed to her lack of confidence in her ability to disassemble a toy and then reassemble it.

When using the 'interpersonal plane' it is evident that guided participation interactions involving tinkering, appeared to be absent in her childhood, and family values strongly influence her approach to tinkering.

It is to be noted that for some of these examples, the community plane was not productive in this analysis.

Conclusion

This journal article contributes to the debate surrounding the value of tinkering for young girls. The data were e-journals, posted online by female primary teacher trainees in their final year of study. In many of the e-journal entries the trainees recollected their experiences of tinkering when they were young. Most responses revealed how they 'felt' about participating in tinkering activities, rather than the scientific understandings they developed. This affective dimension is often overlooked, yet it is highlighted in this online learning environment.

A socio-cultural perspective reveals that participation in tinkering activities is complex, with many factors influencing the trainees' perceptions. Analysis of the e-journals using Rogoff's planes of analysis, showed how the innate characteristics of the individual trainees, the relationships with their parents, and their home upbringing, influenced the trainees' perceptions of tinkering. Using the 'personal lens' of analysis, some trainees identified that as young girls they were reluctant to tinker because they perceived it as being destructive. Others revealed that their interest in tinkering came from their individuality and seems to be innate. Another group experienced a current fear of tinkering that stems from their childhood experiences. The lack of tinkering

experiences as they grew up, meant that as adults they were not confident to tinker. The interpersonal plane showed that the gendered roles of parents affected some trainees' views of tinkering. While it was clear that some parents were mentors, and encouraged their children to engage in tinkering activities in the home environment, other parents were not. The trainees identified stereotypic role models within the family. As young girls, some felt restricted in their family where tinkering was considered to be only a male activity. Others were encouraged to tinker by family members, including their mothers. Guided participation involving tinkering appeared to be absent in some girls' childhood. For others, family values strongly influenced their approach to tinkering.

A 'community/institutional lens', although of limited use for the data in this study, shows that most teacher trainees recognise the benefits of providing tinkering experiences for girls at school, and that as teachers they intended to implement this strategy in their classrooms. The study has implications for primary and early childhood teachers as well as parents. Results of the study give renewed support for teachers and parents to provide girls with tinkering experiences in their early years.

Overall, data analysis from a socio-cultural perspective, showed that these primary teacher trainees have many of the issues found for young girls. Results indicate that teaching technology is as much about winning hearts as minds. These personal reflections on very deep responses to technology must be an important part of preparing teachers to deal with young children's learning and responses.

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