

# The Collaboration-Authentic Learning-Tool Mediation (CAT) Framework: The Design, Use and Evaluation of an Academic Professional Development Workshop

Alan Amory  
Centre for Academic Technologies  
University of Johannesburg, South Africa  
aamory@uj.ac.za

**Abstract:** The aim of this research is to use an educational research design approach to design, implement and evaluate a professional development intervention workshop to support the teaching, learning and assessment practices at a South African university. The workshop was specifically designed to support the institutional goals that learning be conceptualized as becoming a practitioner of a knowledge and professional domain, that recitation of information limits optimal learning, and that Information and Communication Technology tools need to support innovative teaching. The derived CAT framework includes core concepts of social collaboration and tool mediation, which are part of the Cultural Historical Activity Theory, and authentic learning as the object of the activity. This framework is used as a heuristic to design, implement and evaluate the workshop. Quantitative and qualitative assessment of workshop activities and artifacts showed that the CAT framework allowed participants to evaluate the pedagogical design of game-based learning reports, design their own learning activities and evaluate the workshop. However, the concept of tool mediation was not fully understood. Future work in the design of the workshop needs to make unequivocal the concept of tool mediation and the specific role for ICT tools as mediators.

## Introduction

Research presented is concerned with the professional development of academic members from a South African University in the use of technology in their teaching, learning and assessment practices. This research makes use of an educational research design approach (McKenney & Reeves, 2012), focuses primarily on a workshop intervention, and asks how contemporary social constructivist principles allied to authentic learning could support academic development. It is therefore pertinent to report against the generic model for conduction design research in education (Figure 1).

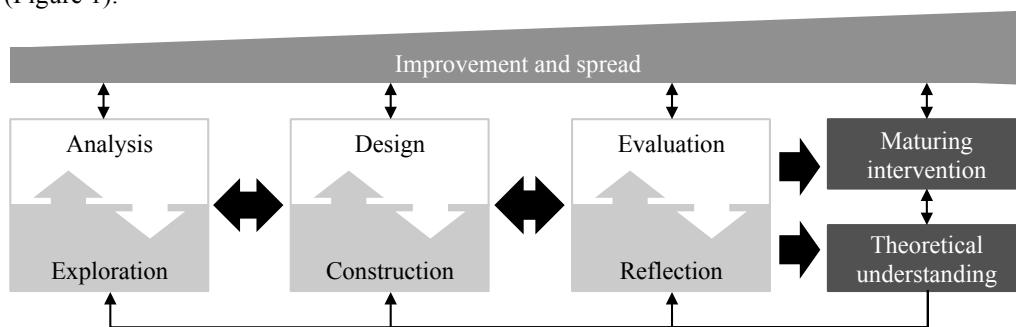
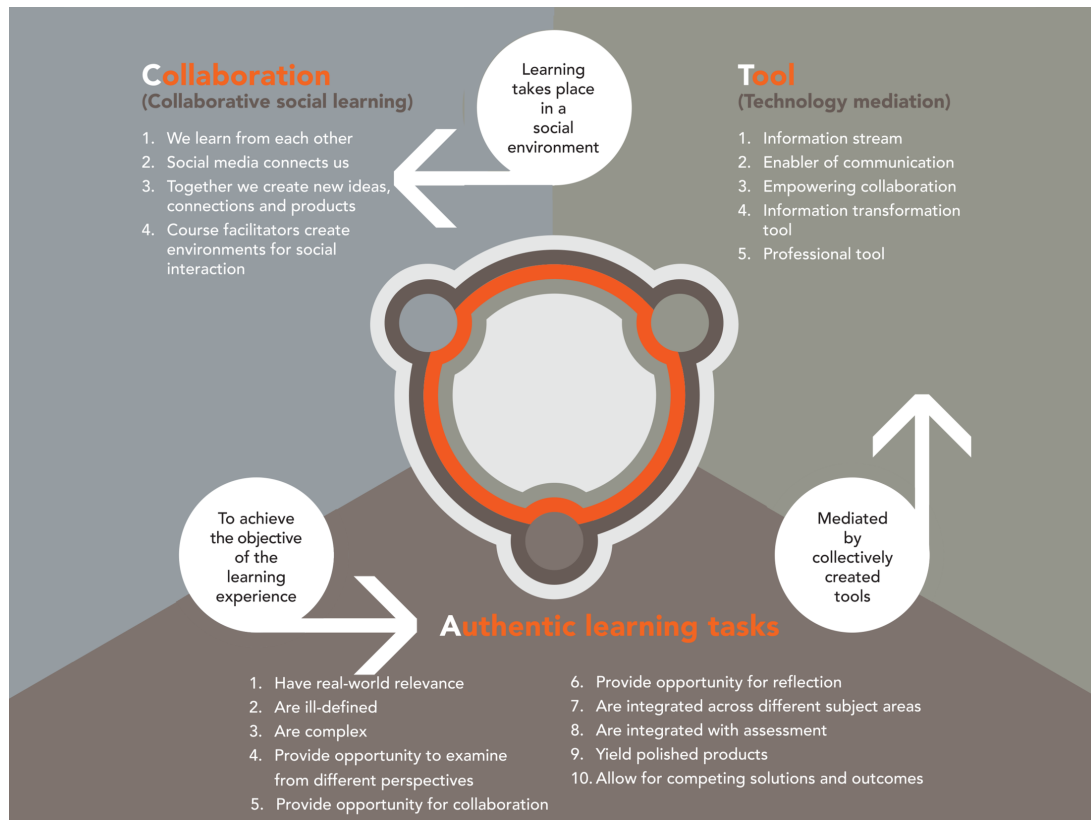


Figure 1: Educational design research (redrawn from McKenney & Reeves, 2012, p. 77)

## Analysis and Exploration

A number of years ago Amory, Gravett and Van der Westhuizen (2008) wrote a position paper for the institution, on which a policy document on a teaching and learning philosophical approach for a comprehensive university was based. They posited that as the new millennium introduced complex challenges to a university, learning should be conceptualized as becoming a practitioner of a knowledge and professional domain, that an

information-oriented (recitation of information) approach limits optimal learning, and that Information and Communication Technology (ICT) should extend contact teaching in innovative and digitally rich ways. However, prior to 2012, professional development in the use of ICT in teaching, learning and assessment at the institution was limited to training staff members in the use of the institutional Learning Management System to support a *learning from technology* position (Jonassen & Reeves, 1996). In order to more closely align teaching and learning practices with the institutional teaching and learning philosophy, a review of these training practices was undertaken in order to develop a new framework to support a *learning with technology* position (see Amory, 2013). This Collaboration - Authentic learning - Tool mediation (CAT) framework is briefly described here and the theoretical frame is used to underpin the design and delivery of a new professional development workshop. The research presented here explores the participation of university staff members in the workshop and analyses the artifacts developed by participants.



**Figure 2:** The Collaboration - Authentic Task - Tool Mediation (CAT) framework

The CAT framework is built on the core concepts of social collaboration and tool mediation that is part of the Cultural Historical Activity Theory (CHAT) (Leont'ev, 1978; Vygotsky, 1978; Engeström, 2001), and authentic learning (Reeves, Herrington, & Oliver, 2004) as the object of the activity (Amory, 2011, 2012) (Figure 2).

All activity, either inter- or intra-psychological, is social and cultural in nature and involves actors transforming an object (Leont'ev, 1978). Furthermore, objects develop during human activity as they are part of communal transformational practices (Stetsenko, 2005), and in an activity system are the most basic concepts (Kaptelinin, 2005) and prime unit of analysis (Engeström, 2001). However, all the social processes associated with learning, consciousness and development of human higher cognitive functions are mediated through the use of cultural tools, including physical *tools* (such as pencils and technological artifacts), and the psychological *signs* and *symbols* (especially language) (Vygotsky, 1978). Tools are orientated to material activity, while signs and symbols are part of higher cognitive functions, such as solving problems.

Wertsch (2007) categorized Vygotsky's formulation of mediation as either explicit or implicit. Explicit mediation is when an individual intentionally introduces a tool, or sign, into an ongoing stream of activity that is non-transitory and obvious. Implicit mediation is less obvious but involves language and communication. Both

explicit and implicit modes of mediation are involved in every activity. Another point made by Vygotsky (1978) is that the development of higher mental functions in a child occurs twice: first on the inter-psychological (social plane) and later on the intra-psychological one. As language is the most important tool of social interactions, it is therefore a most important semiotic tool. Lastly, language also mediates inner speech when individual thinking becomes conscious once written or spoken. Therefore, due to the importance of tool mediation and semiotic interaction, the CAT framework includes these as part of collaboration and tool mediation, respectively. However, the object of the activity and the role of technology in this model need further exposition.

Amory (2012) posited that as technology-supported learning environments should support complex human, social and cultural interactions (Amiel & Reeves, 2008); include rich contexts, authentic tasks, active, autonomous learning and co-operative learning (Smeets, 2005); and cognitive apprenticeship (Brown, Collins, & Duguid, 1989), the object of the activity should be an authentic task as described by Reeves, Herrington and Oliver (2004).

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- Ice breaker: YouTube video  
<http://www.youtube.com/watch?v=soAk3F0wX9s&list=PL0B358C82642BAE53&index=1>
  - Introduction: via a discussion forum
  - Activity 1: Your HOD has just had one of those cathartic moments: game-based learning is the way to go! While this may be an interesting development, the HOD has asked you, as one of the productive researchers in your department, to undertake a small research project to evaluate how games, one of the most complex technologies available to teachers, could be used in teaching and learning. To help you, the HOD has provided you with a number of papers and a review instrument that you could use to evaluate the teaching designs and outcomes detailed in each paper. The HOD has requested that your evaluations should be presented as a mind map to the members of your department.
    - Task 1: With a *colleague*, **read the paper abstracts** to gain a general understanding of the ideas, research methodology, results and findings. *You and your partner* need to complete the online review for each paper using the **review instrument\*** – a Google form based on the CAT framework.
    - Task 2: Use this **data** (Google spreadsheet) collected during the first activity to **visually analyse the data with your colleague** and individually **create a mind map\*** using **FreeMind** for the HOD. Export your mind map as a PDF file and post it to the forum for *group discussion*.
  - Presentation of the CAT framework
  - Break
  - Presentation of the TED video on the first AI MOOC and class analysis using the CAT framework  
[http://www.ted.com/talks/peter\\_norvig\\_the\\_100\\_000\\_student\\_classroom.html](http://www.ted.com/talks/peter_norvig_the_100_000_student_classroom.html)
  - Activity 2: A lecturer, who teaches first-year students, has approached you with an idea for a new online learning activity. The lecturer suggested that a recent newspaper article, entitled "Fracking up the Karoo" (Sunday Times, 5 August 2012), could be used as part of this activity. The lecturer also requested that the activity should take about two hours to complete and be based on the principles associated with authentic learning. Prior to implementing the design, you have been asked to prepare a presentation to the lecturer's department.
    - Task 1: Using the core concepts of authentic learning, social collaboration and tool/technology mediation knowledge construction (**the CAT framework**), *work with your partner* to design the learning activity. Prepare a **presentation\*** of your ideas using Google presentation, a *collaborative authoring* tool.
    - Task 2: Share your Google presentation with the workshop facilitator for a *class discussion* on your task designs.
  - Workshop evaluation using the **CAT framework online instrument\***.
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**Figure 3:** Final workshop design highlighting **explicit** versus *implicit*, and tool versus sign mediation<sup>1</sup> (\* denotes artifacts used for analyses)

Technological affordances are often used to describe how to design learning that makes use of technology (Conole & Dyke, 2004). Affordance “are meant to offer an example as to the fundamental, pragmatic, and functional

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<sup>1</sup> Think of explicit mediation as “dropping” a tool into an activity and thus requires some **weight**; as implicit mediation is about language and we often use *italics* to quote someone; and as the use of signs requires higher order functions such mediation is underlined twice while material tool requires a single underline.

level at which affordances should be identified in order to be suitable for matching to the affordance requirements of various learning tasks” (Bower, 2008, p. 8). But such a use of technology could be defined as part of material tool mediation. Amory (2012) argued that technology be separated into actions (content delivery, communication, collaboration, transformation and tools of a profession) that can either mediate as tools or as signs, depending on the context. The CAT framework therefore encourages the design of learning and professional development workshops to explicitly make use of authentic tasks that include collaboration and tool mediation.

## Workshop Design and Construction

The academic professional workshop includes two main activities: participants acted either as student or as learning task designers. The final workshop design is presented in Figure 3. Purposefully selected participants (experts in staff development, use of technology in the classroom and curriculum design) participated in the first three workshops, and thereafter participants responded to an open invitation. Initially the workshop was scheduled over two morning sessions. However, after the first iteration, participants felt the cohesion between the two main activities was lost and the workshop was redesigned for a single one-day session. Thereafter, the workshop was presented for an additional six times and after each iteration small changes were made to the instructions and manner of facilitation. For example, as participants found the use of the CAT framework instrument to assist (mediate) in the understanding of the pedagogical approaches of each paper, additional facilitation was required and the text changed to indicate that they did not need to review the papers but only the pedagogical approaches embedded in the paper. Amory (2013) details a full description and analysis of the development of the CAT framework and associated workshop.

## Evaluation and Reflection

An eclectic-mixed methods-pragmatic (Reeves & Hedberg, 2003) approach was used in this inquiry as both quantitative and qualitative methodologies were used. Seven iterations of the workshop were presented to a total of 36 participants. Artifacts collected (see Figure 3) included from Activity 1 the CAT review instrument and the mind maps plus the graphical presentation of data; from Activity 2 the learning task designs; and the workshop evaluations. Quantitative analyses were conducted using SPSS version 21 (IBM) while deductive coding using the CAT framework was used for qualitative analyses.

This CAT framework instrument is used in three different ways during the workshop: As an explicit sign to mediate the understanding of the pedagogical practices of each paper, to support the development of a new learning activity, and to evaluate the workshop. These analyses attempt to answer two questions: Is the instrument reliable and can participants use the instrument consistently and in different ways to mediate knowledge construction? The aim of the data visualization and mind mapping exercises was to illustrate tool mediation. First the results associated with the CAT framework are presented and then the data visualizations and mind maps analysis.

### Instrument Reliability

Paper	Instrument		Participant	
	n	Cronbach's $\alpha$	n	ICC
1	18	0.92***	7	0.06
2	18	0.78**	6	0.25
3	18	0.84**	6	0.49*
4	18	0.93**	9	0.18
5	18	0.90**	6	0.50

**Table 1:** Reliability (Cronbach's  $\alpha$ ) of and participant scoring (Interclass Correlation Coefficient) of the papers using the CAT framework instrument (Significance: \*\*\* = < 0.001, \*\* = 0.001, \* = 0.01)

The 17 elements of the CAT framework (Figure 2) were converted into 6-point Likert items (not implemented to fully implemented) using Google Forms. Initially explicit and implicit mediation were the first items of the instrument. However, due to the complexity of the meaning associated with these items, they were moved to the last section of the instrument. To determine the reliability of the instrument Cronbach's  $\alpha$  was calculated for each paper and for the consistency of participants' responses per paper the interclass correlation coefficient (ICC) was calculated using the two-way mixed model of type absolute agreement (Table 1). Cronbach's  $\alpha$  for paper 2 was 0.78 and for the other papers it was above 0.8 indicating a high degree of item reliability. All the values were significant at  $p \leq 0.001$ . However, agreement in participant group scoring of each paper using the CAT framework

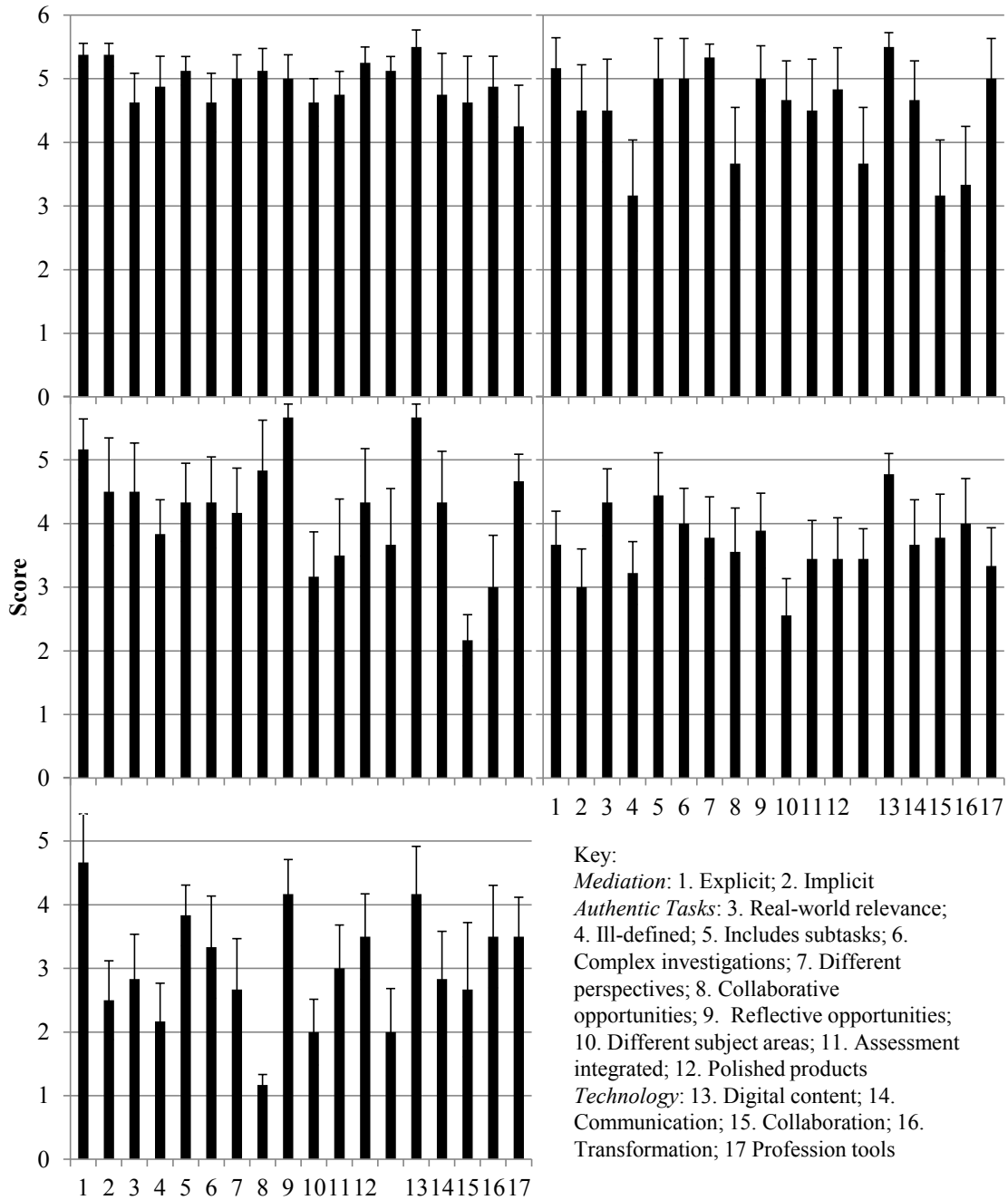


Figure 4: Analyses of five journal articles by workshop participants using the CAT framework instrument (bar=SE)

instrument was not consistent (ICC value < 0.8). However, box-and-whisker plots illustrated that many groups scored in a similar way, some groups ranking instrument items either much higher or lower than did their counterparts.

### Paper evaluation by participants using the CAT framework

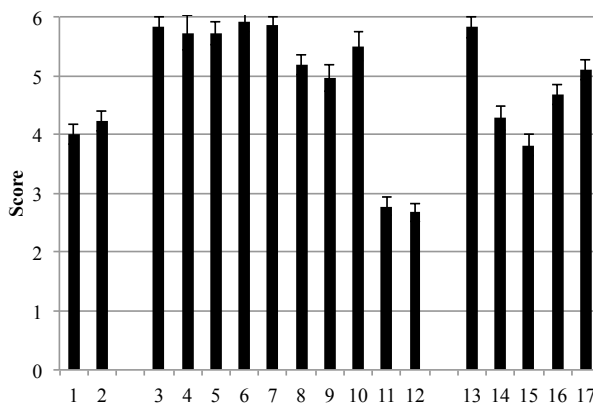
Despite these inconsistencies, which may be due to a lack of understanding of the theoretical constructs associated with each instrument item by individual groups, the analyses of the responses for each instrument item per paper are noteworthy (Figure 4 – papers are arranged from those that fully implemented most of the CAT framework components to those that implemented only some of the components).

The pedagogy of the top rated paper was based on an authentic task where children, working in groups and supported by parents and teachers, made an adventure game. The paper reported that the participants were enthusiastic, motivated and were determined; worked alone and learned collectively; and were able to transfer knowledge from this learning activity or other situations. In this example the game functioned as explicit sign mediator and the pedagogical design included many opportunities for implicit mediation.

The paper that was least compatible with the CAT framework was one where investigators made use of a control group experimental approach to identify the potential gender differences, learning effectiveness and motivation of playing trivial games. Children participants either played a computer game or had access to other non-game resources. Pre- and post-tests of computer memory knowledge and attitudes were determined. Girls and boys performed in a similar way and the game appeared to motivate the learners. In this example, the game functioned as an explicit tool mediator and the pedagogical design made little use of implicit mediation.

It should be noted that the evaluation of the papers is not about the scientific value of the publications, but about the fit with the CAT framework. However, the different pedagogical approaches do show that in the paper rated the highest the students developed higher order cognitive skill, while those who participated in the lowest scoring paper increased their memory recall in the short term through a computer-based recitation teaching model.

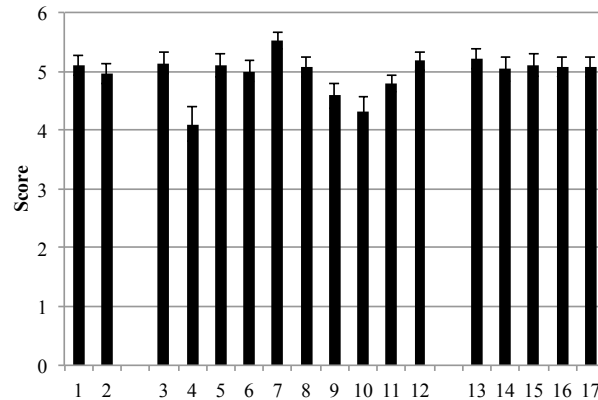
### Learning activity design evaluation using the CAT framework



**Figure 5:** CAT framework instrument analysis of learning activities designed by participants ( $n=22$ ; bar=SE; see Figure 4 for the instrument items descriptors 1-17).

I used the CAT framework instrument to evaluate the 22 learning activity designs created by the participants as the outcome of the second major activity (Figure 5). The concepts of explicit and implicit mediation were not sufficiently included in the learning activities. This support previous results and observation that the concept of mediation is complex and may need additional explanation during the workshop. Many of the items associated with authentic learning were well-implemented except that the integrated assessment criteria were not well-formulated and little opportunity was given to students to revise their work. A common problem with assessment is that academic staff members do not explicitly link assessment to the tasks (Biggs & Aldrich, 2011). It was disappointing that participants did not include sufficient technologies into the teaching activities to support the material tool mediation. However, this was a very new and challenging concept for most of the participants.

## Workshop evaluation by participants using the CAT framework



**Figure 6:** Analysis of the workshop by participants using the CAT framework instrument ( $n=30$ ; bar=SE; see Figure 4 for the instrument items descriptors 1-17)

The CAT framework instruments were also used to evaluate the workshop (Figure 6) but included an open-ended question for any comments the participants wished to make. Thirty of the 37 participants completed the evaluation. Analysis of the results showed that most of the items were rated 5 out of 6 (fully implemented); three items (Ill-defined and Included different subject areas) were rated lower (4.1 and 4.3 respectively). The ratings are constant with expectations except for the lower rating for ill-defined tasks. During the workshop the concept of ill-defined tasks generated heated debate so this could be an area that is contrary to what academic members think about teaching and learning. With respect to the open-ended question, only one the 13 comments was negative (related to confused workshop arrangements) and the rest were positive, for example:

“An insightful workshop that helps us understand how simple changes to thought and application can help in getting students to learn something old in a new way.”

“I loved the workshop! I so much appreciate the departure point of authentic learning, focused on skills and perspective, rather than content. I enjoyed the engagement, and the discussions at the end. Maybe mid-way through the workshop a discussion session would be useful.”

“This was a very interesting workshop. I like the way it was structured because it allowed us to think and do things ourselves unlike being told what to do and how to do it. I can now learn to be and learn cognitively.”

## Visualization and mind mapping representation

The objective of this part of the study was to illustrate that technological tools mediate the representation and understanding of complex data. Participant group data of the paper evaluation, captured in a Google presentation document and exported to Excel, was made available to the participants. I quickly demonstrated how to convert the data into bar graphs to show participants that they reviewed the papers in different ways (similar to Figure 4). Thereafter, working individually, the participants used this data to create a mind map representing the best way to use games in the classroom for presentation to the class. It was interesting to note that some of the participants were unfamiliar with creating graphs in Excel and few participants had previous experience with mind-mapping software. The participants submitted thirty mind maps. Visual representation and complexity of the mind maps were analyzed using a three-point scale (none – attempt – satisfactory). Forty-four per cent of the submissions showed good use of data visualization, 13 per cent made some attempt and 33 percent of the mind maps did not include graphs. With respect to their mind maps, 70% produced a satisfactory result and 30 per cent made some attempt. Three of the most complex mind maps lacked any graphical representation. These results suggest that participants used technological tools in ways that support their individual modes of communication to represent their ideas either using text only, or using text and graphics. Furthermore, all participants successfully learned to use the mind-mapping tool. Unfortunately, the objective of this exercise to demonstrate material tool mediation was only

partially transferred by participants to their own designs that did not include the use of ICT tools to transform information (Figure 5).

## Discussion, recommendations and conclusions

The educational design research generic model suggests two main outputs: theoretical understanding and maturing interventions. The work reported here is the first macro cycle of a design experiment that included a number of analysis and exploration micro cycles, and seven design and construction micro cycles and a single evaluation and reflection cycle. The research explored the effective use of the CAT framework to support academic professional development with the specific intention to align the teaching, learning and assessment practices of a comprehensive university with the concept that learning is about becoming a practitioner of a knowledge domain, that recitation of information limits optimal learning, and that ICT should enrich contact teaching in innovative and digitally rich ways (Amory et al., 2008).

The theoretical underpinnings of this intervention are aligned with the core CHAT concepts of social collaboration, tool mediation (Leont'ev, 1978; Vygotsky, 1978; Engeström, 2001) and authentic learning (Reeves, Herrington, & Oliver, 2004) as the object of the activity as posited by Amory (2012). He put forward the declarative design principles that activity theory supports course design and evaluation; authentic learning tasks promote effective learning; and educational technology (as tools) mediates knowledge construction. These three principles were incorporated into the theoretical CAT framework that was used in the design, implementation and evaluation of a professional development workshop (Amory, 2013). The work reported here supports and expands the use of CHAT and authentic learning as an appropriate theoretical construct used, not only for the design of the intervention, but as a heuristic to support tool-mediated knowledge construction. More importantly, the notion of using authentic learning tasks as the *object of an activity* is clearly demonstrated and supported.

With respect to the practical implementation of this workshop a number of issues need further exploration. While the CAT framework assessment instrument mediated workshop participants to identify contemporary pedagogical practices, plan their own learning activities and evaluate the workshop, explicit and implicit mediation involving either tool or sign, were not fully appreciated. This is evident from both their evaluations of the papers, the use of tools for visual representation of ideas (mind mapping) and the use of tool mediation in their learning activity designs. In addition, while the concept of tool mediation was present in some of their designs, the link to the use of ICT tools to support such a concept was either limited or superficial. However, these critiques should be viewed in relationship to the positive attitudes of the participants to, and the interesting and diverse practical outcomes of, the workshop. Therefore, the future development of the workshop needs to consider that participants should develop a deeper understanding of tool mediation. This might be accomplished with a facilitated discussion around the theoretical principles and, through reflection, identification of explicit and implicit mediators that are part of the first activity. In addition, ways in which ICT tools could be used in the classroom should be explored. However, this may form the content of another workshop.

In conclusion, the development of a theoretical framework that includes CHAT (social tool-mediated knowledge construction) and authentic learning as the object of the activity provides a powerful heuristic to design, implement and evaluate a professional development workshop for staff at a comprehensive university.

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