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Technology Teachers' Conception of the Design Process

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ABSTRACT There is much concern in South Africa about how the design process (DP) is taught and its impact on learner creativity. This paper reports on a study that explored technology teachers' reported conception and their reported enactment of DP and its impact on learner creativity. It addresses the following research question, what are technology teachers' reported conceptions and enactment of the design process and how do these conceptions impact learner creativity? A case study approach was used to collect qualitative data using an open ended questionnaire and video recorded interviews. The findings indicate that teachers conceive DP, as cyclical and as step by step. Teachers' conceptualisation of the design process sculpts and in some instances limit their enactment of DP which impacts the opportunities for learner creativity. It is recommended that technology teachers' need a planned intervention to support their enactment of DP in order to promote learner creativity.

INTRODUCTION

Since the introduction of technology education within the South African school curriculum in 1998, teachers have experienced the following policies namely: Curriculum 2005 (C2005), Revised National Curriculum Statement (RNCS) and now the Curriculum Assessment and Policy Statement (CAPS). According to the CAPS policy the purpose of technology education for learners is to "develop their creative and critical thinking skills" (DBE 2011: 9). Each of the aforementioned policies have emphasised that the design process is the core of the Technology subject and it ought to be used as an avenue for developing creativity, critical thinking and problem solving skills in learners. Although the link between the design process, teaching and learner creativity is emphasised in the above policies, there are few studies within the South African context which devote attention to the design process (Mabaso 2015; Appiah 2015). Research that can inform others about technology teachers' conception and enactment of the design process and how their conceptions impact learner creativity is needed so the design process can be used to foster learner creativity. It is for this reason that the researchers set about exploring technology teachers' conception and enactment of the design process and its impact on learner creativity in the Chatsworth West Ward (CWW) of the Umlazi district in Kwa Zulu Natal.

In this paper data collected from 12 technology teachers via questionnaires and interviews are analysed. The purpose of this paper is two-fold: 1) to establish technology teachers' conceptions and enactment of the design process and 2) to illuminate the impact of their conceptions on learner creativity. Based on the analysis, the goal of the study was to make recommendations on how to improve teachers' conception and enactment of the design process in order to create opportunities for learner creativity.

Literature Review

The successful implementation of the design process, is dependent on teachers having a solidly established personal understanding of technology education goals, its related content and the necessary pedagogical knowledge (Apphia 2015). As such teachers' conceptions of the design process often impact their enactment. In this paper the focus is on technology teachers' conception and enactment of the design process as well as the impact of their conceptions on learner creativity.

Williams (2014) and Mawson (2003), assert a common view amongst teachers, which is the understanding of the design process as a product based or a linear process. This means, the design process is construed as a series of steps that are outlined by the teachers, viz. identify-design-make-appraise, and learners are expected to follow these steps sequentially and diligently in their projects. The foregoing approach of the design process foregrounds the production of a product (Mawson 2003), assessment (Wong et al. 2012), does not provide enough room for developing the creative skills of the

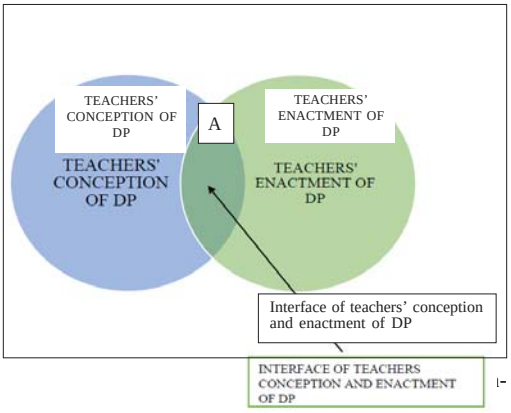
learner (Lewis 2006) nor does it allow for learner autonomy (Rowel 2004). The ideology behind this systematic process, Williams argues, is that it can be taught. This rigid procedure is inviting to teachers, because it provides a structure for the teaching of Technology. Appiah (2015), contends that associating steps in the teaching of design and problem solving may be the crutch that teachers cling to as a result of the tension between their conception of the design process and the pedagogy they use to facilitate the design process. An opposing view is held by Tunstall (2007), Aspelund (2006) and Peto (1999). These scholars support the linear model of the design process as it is systematic and novice designers are capable of applying the suggested procedures as they make their own designs.

The seemingly rigid nature of the identify-design-make-appraise model of the design process beckons an alternative pedagogy or approach. Hill (1998) directs our attention to the disparity between the design process employed in problem solving in real life contexts and that which is found in the classroom. As she alludes, "In problem solving for real-life contexts, design processes are seen as creative, dynamic and iterative processes that engage exploration; join conceptual and procedural knowledge-both thought and action; and can encourage considerations to technology, human and environmental interactions" (p. 203). This means the complexity of the design process stems from its cyclical and iterative nature and that possible solutions come from a complex interaction between parallel refinements of the design problem and ever-changing design ideas. The approach suggested by Hill (1998) is antithetical to what is typically found in schools: design, make and appraise cycles based on closed design briefs that are teacher assigned which incidentally are unrelated to the students' world.

Design is perceived by Asunda (2007) as a structured process that transforms creative ideas into concrete products, services and systems, and as such, links creativity to innovation. Creative thinking produces novel outcomes and problem solving produces a new response to a situation, which is a novel outcome. Therefore, problem solving has creative aspects. According to Asunda (2007), Vandeleur et al. (2001), Davis (1999) and Wakefield (1996), some of the key indicators of creativity during the DP is freedom to generate ideas; flexible use of space and time; availability of appropriate materials; room for experimentation; non-conformity; justification of choices and ability to see a solution; generation of new problems; relationship between teacher and learner; opportunities for collaboration with peers. The flexibility with which the DP is enacted impacts learner creativity, problem solving and critical thinking.

Conceptual Framework

The researchers drew on Singh-Pillay's (2010) notion of interface to interface teachers' reported conceptions of DP with their reported enactment of DP. According to Singh–Pillay (2010) the interface arises out of points of convergences or divergence between people's views or practices. It is this understanding that is applied in this paper. The concept of an interface is construed as a meeting point (convergences) or a point of deviations (divergences) amongst teachers' reported conceptions and reported enactment of DP as shown in Figure 1.



Source: Authors

The interface (point A in Fig.1) will bring to the fore the relational interplay between teachers' reported conception of DP (their content knowledge, knowledge of the curriculum), their reported enactment of DP (their pedagogical knowledge) and opportunities created for learner creativity. The researchers contend that teachers' reported conceptions of DP frames their reported enactment of DP (teaching strategy, knowledge of the curriculum, knowledge of assessment of DP, knowledge of learners learning strategies, professional development received) which ultimately promotes or hinders learner

creativity. Using the above framework will be beneficial during data analysis to understand teachers' conceptions of the DP, as their conceptions are a permutation of content knowledge and it impacts their enactment of DP and opportunities for learner creativity.

METHODOLOGY

This qualitative case study was located in the Chatsworth West Ward (CWW) of the Umlazi district in Kwa Zulu Natal. There are 12 High schools in CWW each school has a minimum of one technology teacher. Purposive sampling was used to identify a senior phase technology teacher from each school. According to Henning (2010:15), "This is a strategy in which particular settings, persons, or events are deliberately selected for the important information they can provide that cannot be taken as well from other choices". This means the respondents had to be teaching senior phase Technology to be a part of the sample. Formal permission to conduct research was obtained from UKZN's research office and the KZN Department of Education to conduct this study at 12 schools.

Data were collected in 2 phases. During phase one twelve teachers answered an open ended questionnaire, which was designed with the assistance of university researchers to foreground teachers' reported conception of DP and their reported enactment of DP. The questionnaire was piloted with teachers of technology to improve its validity. The questionnaire comprised of two sections. The first section targeted biographical data in terms of qualification, institute at which qualification was received, number of year teaching, subjects taught, professional development received to teach technology and knowledge of the technology curriculum and its content. The second section consisted of open ended questions to gather information on teachers' conception and understanding of the design process, knowledge of the technology curriculum and its goals, role of DP in learner creativity, autonomy granted to learners during DP, the importance of the design process in teaching technology, planning they under took to teach DP, aspects of the design process that are emphasised during teaching, how DP is assessed, emphasis placed on learner creativity during DP, and training received for curricula reform in technology. The information obtained from the questionnaire was used to map the technology education topography within the CWW in terms of teachers' conception of the design process and learner creativity. For the purpose of this paper we will only focus on data pertaining to teachers' conceptions of DP and its impact on learner creativity.

For phase two of data collection, video recorded semi-structured interviews were conducted with the 12 teachers who participated in phase one of data capture. The purposes of the semi structured interviews was to probe teachers' responses, from the questionnaire, and establish what influence or impact teachers' conception of the design process has on their enactment of DP and on learner creativity. The video recordings were transcribed and sent to the teachers for member checking.

The research question posed in this study was used for organizing the analysis. In using this approach all the relevant data from data sources (questionnaires and interviews) were collated to provide a collective answer to the research question. This was in line with the explanation given by Cohen et al. (2011) that qualitative data involves organizing, accounting for and explaining the data in terms of the participant's conception of the phenomenon being explored, noting patterns, themes and categories and regularities. Data was read and then coded using the elements of the researchers' conceptual framework (see Fig. 1). The goal of content analysis is "to provide knowledge and understanding of the phenomenon under study" (Downe-Wamboldt 1992: 314). Codes were (re)examined to form four categories, on the conceptions of DP, teaching and assessment strategies used, teacher qualification/training received and links between teaching strategy and learner creativity. The four categories were integrated to arrive at two themes: teachers' reported conception of DP and their reported enactment of DP. In using this approach all the relevant data from data sources (questionnaires and interviews) was collated to provide a collective answer to the research question. The researchers' conceptual framework was used to understand if there is an interface between teachers' reported conceptions of DP, their reported enactment of DP and learner creativity.

RESULTS

In this section the researchers first present their findings from the questionnaire and second from the semi structured interviews.

Data from the questionnaire reveal that all 12 teachers conceptualized the design process as the core activity in technology education as is illustrated in the excerpts below:

T5: *"It is the most important process in technology education"*

T6: *"It is what drives technology and innovation"*

T8: *"It is the backbone of technology education"*

The above finding corresponds with the philosophy of scholars such as Mawson (2003), Howard-Jones (2002) and the CAPS policy (DBE 2011) on the design process being the core of technology education. The implications are that the design process ought to guide teaching and learning in technology education and should be used to promote learner creativity and critical thinking. An interesting finding from the questionnaire is that all 12 teachers' construed the design process as a problem solving activity as reflected in the excerpts below:

T1: *"The design process is a planned structured method to solve problems needs or wants"*

T4: *"The design process is the same as problem-solving, you identify and define the problem, also solve the problem"*

T9: *"It is the same process like problem-solving"*

T12*:* "I*t's a successful solution to a problem"*

The above excerpts elucidate that these teachers do not differentiate between the design process and problem-solving. In other words, the design process is construed to be similar problem-solving, hence the underlying expectation that the design process would be used to promote learner autonomy and creativity. The above finding warranted further probing during the semi structured interviews. It is worth noting, that the data obtained via the semi structured interview illuminates that teachers hold two very key conflicting/contradictory views on the design process as a problem solving activity, namely:

- Design process as cyclical/ iterative and
- Design as a step-by-step process that provides "comfort" to learners during problem-solving.

Design Process as Cyclical

Only two of the 12 participants viewed the design process as being cyclical or iterative as reflected in the excerpts below:

T5*: "The design process is an iterative process to solve problem…..developing original ideas to meet the needs or wants, it should allow for creative designs, and solutions from learner they skip stage, work simultaneously on refining ideas, design and the product"*

T8*: "It's a cyclic process, not a linear way to solve problems, learners must be given the chance to think and come up with novel ideas to solve problem in their context"*

For these teachers the design process is not reduced to a "cook book recipe" whereby learners follow the steps of the design process in a sequentially progressive fashion. For T5 and T8 the stages/steps of the design process lack sequential rigidity; rather it is an iterative process that involves back and forth movement between stages or the skipping of a stage to refine ideas and the end product. The above excerpts highlight the complexity of the design process that arises from its cyclical and iterative nature where possible solutions come from a complex interaction between parallel refinements of the design problem and ever-changing design ideas.

The above two teachers' conception of DP elucidates the iterative nature of DP as well as the ongoing evaluation process that occur during DP. Evaluation is a critical component of creativity. The back and forth movement between stages is a mark of creativity as it entails a repeated (re)view or critique of existing ideas, noting strengths and areas of weaknesses that need to be improved. It is significant to note that these teachers' views are aligned with the CAPS senior phase technology policy's notion of the design process (DBE 2012).

In addition, these two teachers construe the design process as being related to critical thinking and creativity wherein it involves the generation and realization of new ideas and problem solving. In other words, for these particular teachers the design process is not reduced to a mere "step by step formulaic activity". For these two teachers learners are engaging in critical thinking, when they think /interrogate the multiple solutions to any problem as well as multiple ways to work towards solutions for the identified problem. The implications are that learners are free to make choices as reflected in the excerpts below:

T5: *"They must be creative and yet achieve its purpose. Try not to copy ideas, create your own design by thinking outside of a box"*

T8: *"Sometimes a child may have one of the better solutions which I as a teacher would not have thought about. They are doing projects on their own, some of them come up with really good examples"*

These teachers' conception of DP as cyclical reflects there is no singular path to reach a solution and that DP is not algorithmic. These teachers' conception of the design process indicate that they encourage problem-solving in diverse and creative ways *(solutions which I as a teacher would not have thought about*) as far as design-related problems are concerned. These teachers construe DP as a creative process, whereby creativity can be nurtured if opportunities are provided for learners to generate original alternative solutions. Furthermore, they allow learners to take control of the "learning" during the design process (*they are doing the project on their own; create your own design*). Originality (*create their own designs*) which is a central aspect of creativity is being fostered in learners when they are given the freedom to generate their own ideas. In an inconspicuous way, these teachers reported enactment of DP, encourages their learners to be confident, original and different in their thinking. This particular finding concurs with what Appiah (2015) and Asik (2010) refers to as learner autonomy. Both these scholars maintains that learner autonomy is the independence from the control of others during learning and it can only occur in a learner-centred classroom. The above excerpts exemplify the intrinsic link between teachers' reported conception of DP, and their reported enactment of DP and the opportunities created for learners to be creative during DP. Therefore, an assumption can be made that these two teachers have learner-centred classrooms.

What is worth noting about these teacher's views is that when we traced the response to the biographical data, these particular teachers have been engaging with technology education for more than 10 years, they teach in well-resourced schools, they have attended and participated in seminars in technology education at a local university. One can reason that their years of experience engaging with technology education, being *au fait* with the curriculum and its content have impacted their conception of DP, and their embracing of learner-centred classroom pedagogy as well as allowing for learner creativity.

Design Process is a Step-by-Step Process that Provides Comfort to Learners during Problem-solving

An interesting finding that presented itself within the data collated from the interview was 10 of the 12 teachers who considered the design process to a problems solving activity also saw the design process as a step-by-step process that provides comfort to learners during problem-solving. Within this notion of design process the following two categories emerged, namely,

- Design as a specific step-by-step process; and
- Design as a safety net during problem-solving.

Design as a Specific Step-by-Step Process

Six teachers were of the view that the design process consists of specific steps or stages. This view implies that the design process is a rigid, foreseeable, unimaginative, expected, banal, unsurprising linear process as can be inferred from the excerpt below:

T6*: "Basically all the learners need to follow the same steps, I tell them to follow the six steps one after the other, there has to be uniformity to assess the end product"*

T2*: "The steps you need to follow, they must be followed in a set order, when you have to solve a given problem, and the solutions must be the same so it's easier to assess the work or product"*

T7: *"A set of procedures that needs to be followed in a particular order to solve the problem-all learners must work on the same solution, it's easier that way for me to teach and assess the work*"

The views of these six teachers on the design process are antithetical to the CAPS view of the design process as a cyclical and iterative tool that can be used to promote critical thinking and creativity amongst learners. Furthermore, it restricts the design process to a rigid process that unfolds in a particular sequence (*"you identify, define….and solve the problem"*, *"they must be followed in a set order"*). The implication of the above views of the design process is that learners cannot skip stages to reach a solution. These teachers reported enactment of DP indicates that their classroom climate is very controlled, they restricts divergent innovative/ original thinking which are the hall

mark of creativity. According to Williams (2014) and Mawson (2003), a common view amongst teachers is the understanding of the design process as a linear process. In other words, the design process is a series of steps that are outlined by the teachers, viz. identify-design-make-appraise, and students are expected to follow these steps sequentially and diligently in their projects. Mawson maintains that such conceptions of DP, place undue emphasis on the production of a product rather than critical engagement and evaluation that learners undertake during DP.

Design as a Safety Net during Problem-Solving

The step-by-step nature of the design process is considered by some teachers as what makes things easy for students during problem-solving in design. The rigid structure provided by the sequential step-by-step process offers learners some sort of security framework or comfort within which to work when solving problems in technology education. In a surreptitious way, the step by step stages of the design process also offers teachers a security framework or "comfort" to represent the design process as linear as it is easy to teach, especially if their pedagogical content knowledge is not well grounded in technology education as reflected in the excerpt below:

T3: *"The step-by-step process gives learners directions towards the end product and there has to be uniformity, how am I teach it if there are no stages to follow, that is so hard, how can I assess the end product if they are different, I will be assessing forever"*

T9: *"It is not easy for the learners to finish their task and I can only teach design process if I follow the steps"*

T10: *"It is easier to teach the design process in a step-by-step manner because all the products are the same the assessment becomes easy and is completed faster. I also teach another learning area in the FET Phase, so I don't pay too much attention to technology as it is my filler subject"*

T12: *"I don't like teaching DP, in fact I'm not a qualified technology teacher, technology is hard to teach compared to history, I use the step by step way to have control in class so I can do something with the learners"*

In respect of above controversies Williams (2014) posits that the rigid procedure or systematic re-presentation of the design process is inviting to teachers, because it provides a structure for the teaching of technology.

The biographical data indicates that the 10 teachers who construed the DP as a step by step process have very little experience teaching technology education and that they are qualified to teach learning areas other than technology furthermore they have not had the opportunity to attended the training provided by DoE for curriculum implementation hence an assumption can be made that they lack the necessary pedagogical content knowledge to engage with the design process effectively.

DISCUSSION

The researchers' findings confirms that teachers' conception of DP sculpts their classroom climate for enactment of DP and opportunities for learner creativity. Their conceptions therefore form part of the factors that determine if the espoused goals of the CAPS curriculum are a success or failure. Even though the problem-solving activity associated with the design process has been seen as a potentially rich arena for promoting critical thinking and learner creativity (DBE 2012), this certainly was not the case for majority of the teachers' in this study, who conceive the design process as linear or step by step. On the one hand the observations of this study reveal that teachers who construed the DP as cyclical reported of classroom climates that were learner centered, supported divergent thinking, allowed for learners to take responsibility for their learning as well as built learners' confidence to generate original ideas. This means that these teachers conceive the design process as an avenue for promoting creativity, supporting learners' ideas and providing opportunities for divergent thinking of original solution. For these teachers learner creativity is about learners applying imagination and lateral and critical thinking throughout design processes. Innovation arises from the exploration of ideas and evaluating their own ideas, product or processes of the DP. The aforementioned points bring to the fore contextual indicators of learner creativity that resonates with those identified by Asunda (2007), Vandeleur et al. (2001), Davis (1999) and Wakefield (1996) such as freedom to

generate ideas; flexible use of space and time; room for experimentation; non-conformity and ability to see a solution.

On the other hand the observations of this study illuminates that teachers who perceived the DP as a step by step process that promotes comfort to learners reported of classroom climates that were teacher centered, allowed for only one solution to design problem, did not support divergent thinking, did not build learners confidence to generate original ideas nor did they allow for learners to take responsibility for their learning. This particular finding concurs with that of Aspelund (2006), Tunstall (2006) and Peto (1999) who support the linear model of the design process. While the linear model of the design process is systematic scholars such as Williams (2014), Rowel (2004), Mawson (2003) and Hill (1998) are opposed to the rigid nature of the linear or step by step design process conception and enactment as it does not provide enough room for developing the creative skills of the learner. Therefore they have suggested the need for an alternative pedagogy or approach. The observations of this study reveals that these teachers' incessant preoccupation with the identify-design-make-appraise model of the design process and their per-occupation with assessment of an end product sets the stage for their reported enactment of DP, which hinders and impinges learner creativity. Sadly these particular teachers who conceived the DP as a sept by step process that promotes comfort to learners lacked the pedagogical content knowledge, skills and experience needed to create classrooms that foster learner creativity and promote critical thinking. Their step by step conception of the DP is of more comfort for them rather than leaners. These teachers' reported conception and enactment of DP is inadequate to help learners design creatively and is a barrier to learner creativity.

CONCLUSION

This research reported a study which explored technology teachers' conceptions and enactment of the design process and how their conceptions impacted learner creativity. The findings highlight that there is a disjuncture between the technology CAPS policy's envisaged goal for the design process and technology teachers' enactment of the design process. It is recommended that an intervention pilot project be undertaken within the CWW. The purpose of the project should be two folds, first to assist practicing technology teachers with hands on professional development workshops that demonstrate to them how to teacher the design process in order to promote learner creativity. In this way the teacher will be better able to share the vision of the technology CAPS policy and use the design process as an avenue for learner creativity. And second to initiate a community of practice amongst technology teachers within the ward to share resources (human and physical).

It is hoped that sharing the results of this case study provides some insights into the intrinsic relationship between teachers' conception and enactment of DP and how this impacts learner creativity which is a vision of the technology CAPS policy in South Africa.

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