Critical thinking skills for Civil Technology practical assessment tasks (PATs)

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ABSTRACT: It has been established that some teachers in technology education have a narrow understanding of critical thinking skills, which are often neglected. This is a major setback in the teaching of technology learners, particularly the practical component. Explored in this study was phase one of grade 12 Civil Technology practical assessment tasks (PAT) for 2018 in a construction specialisation to determine the extent to which it enhances critical thinking skills. The findings of this study suggest that phase one PAT rarely provides opportunity for a learner to employ critically thinking skills. Recommended as a result of this study is that in phase one of PAT, tasks are provided that encourage solutions that boost critical thinking.

INTRODUCTION

Critical thinking is enshrined in the South African technology education curriculum [1][2]. It posits the application of scientific principles to assist learners with reasoning abilities to establish connections to address real-world challenges. There is a need to constantly explore how technology education, sometimes called technical education, realises it in South Africa. In most cases, such explorations are carried out in classrooms having experienced teachers with a belief that realisation of critical thinking skills may be manifest. What comes out of such explorations is that teachers in technology education have a narrow understanding of critical thinking and often neglect its realisation [2][3].

Also, in a study by Mapotse and Gumbo, it is argued that some technology teachers have a narrow understanding of critical thinking and often neglect its realisation, because most of them have not been professionally trained as technology education teachers [4]. Even though some received professional training during their teaching experience, Reitsma et al argue that their trainers and curriculum advisors were not qualified or were underqualified in the subject [5]. Hence, how can teachers set practical assessment tasks to develop critical thinking skills? Student teachers' views in this study were considered relevant and reliable, because they are at present receiving professional training in technology education in South Africa. Their input relating critical thinking skills is important and adds value to the literature on the subject.

Studies on critical thinking skills pay little or no attention to how Civil Technology practical assessment tasks (PATs) develop these skills. For example, González-González and Jiménez-Zarco explored learning methodologies and resources in the development of critical thinking competency [6]; Yang examined the catalyst for teaching critical thinking in a large university class [7]; and Halpern reported on thought and knowledge for the introduction to critical thinking [8].

Even in recent studies, there is no mention of Civil Technology studies focusing on PATs. For example, Kola conducted a study on how teachers actualise critical thinking skills in the technology classroom [2]; his study was based on the general education and training (GET) phase. Cloete explored challenges and opportunities in technology and education [9]. Blom et al explored information that designers use in a low-resource classroom [10]. Therefore, in this study, it is argued that these researchers, with student teachers as their participants, had little or no contribution on the use of PATs to develop critical thinking skills in Civil Technology. Hence, explored in this study are student teachers' views on the prospect that Civil Technology PATs help to develop critical thinking skills.

DEVELOPING CRITICAL THINKING SKILLS THROUGH CIVIL TECHNOLOGY PATs

Civil Technology as part of technical education in South Africa should prepare learners to succeed through the acquisition of critical thinking skills [1][11]. Civil Technology outcomes should ensure that learners can

demonstrate understanding of the industry, enhance knowledge, skills, values and reasoning abilities, as well as establishing connections to life outside the classroom and address real world challenges [1].

This can also be viewed as a state, where learners do real-life projects, in which real-life practical skills are assessed, monitored and developed [12]. Hence, the structure of the related PAT should be such that learners do projects, the results of which can be sold to factories and businesses, and are able to solve local community and school-based infrastructure problems. This indicates that such a PAT develops critical thinking skills [13].

It may be supposed that PATs for Civil Technology in schools comply with the views by Facione [13], a scholar on critical thinking skills. However, Msila discovered that most technology education teachers are focusing on teaching learners to pass examination, while neglecting the development of critical thinking [14].

Moore proclaimed that the teaching of critical thinking skills is rare in both schools and universities [15]. Therefore, it was prudent in this study that there be exploration of the PAT coming from DBE, an office responsible for upholding quality learning standards in the country, to determine the extent to which their PAT assist learners to develop critical thinking skills. This was explored by a group of student teachers who were in the final year of university training in the subject. The reason behind this choice, was to create understanding of how far these teachers in the making actualise critical thinking skills. This is with hope it will assist other researchers in the field to determine the root cause of having technology education teachers with narrow understanding of critical thinking skills.

At this stage, it is known that a growing number who finish school in the Civil Technology subject cannot find jobs and this is attributed to the poor skills training they receive from teachers [16]. However, Rajibussalim et al argue that the activities given to learners do not develop technical and personal attributes, strong communication and teamwork skills [17]. These are the cornerstones of critical thinking skills. Therefore, the PAT should not ignore these aspects of critical thinking. According to Halpern critical thinking promotes creativity in solving problems and not just in creating new ideas [8]. It is a process where ideas are tested against each other, with the intention being to find the best suitable solution [2].

In this study, the author sought to explore if Civil Technology PATs gives learners a chance to be creative in solving problems and provide opportunities to test ideas against each other to find a suitable solution. Student teachers' views were examined after they reflected on phase 1 of the grade 12 Civil Technology PAT for 2018 in a construction specialisation. These student teachers were guided by Facione on essential critical thinking skills [13].

METHODOLOGY

A quantitative research design was employed in this study, with a qualitative component to obtain insight into student teachers' views on the extent of Civil Technology PAT in developing critical thinking. This enabled the compiling of frequencies of critical thinking skills involved in the Civil Technology PAT. Previous studies of this kind have been carried out through surveys. Also, there have been similar studies to this one; for instance, a study by Molefe et al [18]. Due to the number of participants, a case study was found to be more suitable [19].

Sampling

The sample comprised 32 student teachers in their fourth-year Bachelor of Education degree and registered for the Technology Education course. The questionnaire was administered to respondents during lectures and took one hour and forty minutes to complete; permission was granted by the student teachers. All respondents who agreed to participate were assured they would remain anonymous. Ethical clearance was granted by the ethics committee of the university at which this research study was conducted.

Data Collection Instruments

As data collection instruments, questionnaires and document analysis were employed in this study. It was noted as important that the instruments did not restrict the views of the participants and that variation of data led to greater validity [20].

Data Analysis

Questionnaires were analysed with the Statistical Package for the Social Sciences (SPSS). Participant inputs were converted to percentages for both closed- and open-ended questionnaires using a three-point Linkert scale. Afterwards, participants were given back their inputs to verify that they were a true reflection of the data input. This was done to ensure credibility of the research study [21].

Confirmability involves neutrality of the research interpretations, which can be enhanced by triangulation [20]. Therefore, in this study, the interpretations were checked by a critical friend who checked for compliance and representation to confirm them as a true reflection. Similarly, credibility was emphasised through triangulating the data

from questionnaires *vis-à-vis* document analysis. The questions were guided by Facione's elements of critical thinking skills to ensure validity of the data [13].

CONCEPTUAL FRAMEWORK

The works of Facione were a guide to this study: *Critical Thinking: What is it and Why it Counts* [13]. Facione averred that …*Critical thinking is thinking that has a purpose (proving a point, interpreting what something means, solving a problem), but critical thinking can be a collaborative* [13].

Furthermore, he examined thought-provoking questions that also informed this study. For instance, asked in this study were the questions: What can the strong critical thinkers do (what mental abilities do they have), that the weak critical thinkers have trouble doing? What skills or approaches do the strong critical thinkers customarily seem to display, which the weak critical thinkers seem not to have?

Facione was followed in this study for what he calls: *core critical thinking skills* to determine the extent to which phase one 2018 PAT for the construction specialisation enhanced critical thinking skills [13]. Referred to as cognitive skills and dispositions, Facione tabled interpretation, analysis, evaluation, inference, explanation and self-regulation as cognitive skills at the very core of critical thinking [13]. Where, according to him:

> *Interpretation includes sub-skills of categorisation, decoding significance and clarifying meaning or paraphrasing one's idea in your own words. Analysis meaning examining ideas, identifying similarities and differences between two approaches to the solution of a given problem. Evaluation meaning judging if the given argument is relevant or applicable or has an implication for the situation at hand. Inference meaning to identify and secure elements needed to draw* [a] *reasonable conclusion or predicting what will happen next based on what is known. Explanation meaning being able to present in a cogent and coherent way the result of one's reasoning. Self-regulating meaning to monitor how well you seem to be understanding or comprehending what you are experiencing* [13].

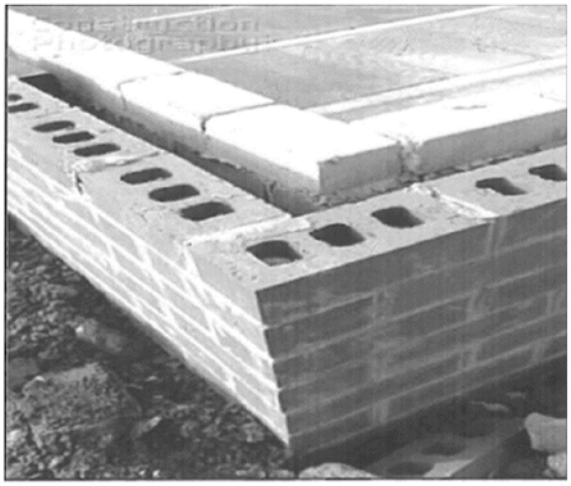
RESULTS

The following activity was extracted from a Civil Technology Curriculum and Assessment Policy Statement (CAP) document for construction.

Phase 1: Brickwork; Term 1; Task: Dry packing of brick for cavity wall (Figures 1 and 2).

Instructions:

- Dry pack the bricks for a cavity wall just above floor level with a 50 mm cavity, five courses high and three bricks long.
- Insert wall ties where required.
- Create weeping holes.
- Insert DPC in the wall to show how water will run out of the weep hole.
- The picture on the left (expected final product); on the right (assessment rubric used for the activity).



MARKING GUIDELINE FOR PHASE 1: DRY PACKING OF BRICKS

LEARNER'S NAME: _____

NO.	ASSESSMENT CRITERIA	MAXIMUM MARK	GOOD/ EXCELLENT	AVERAGE	POOR/NOT ATTEMPTED	LEARNER MARK
			3–4	2	0–1	LM
1.1	Measure and mark the outline on floor of the workshop using required tools correctly	4				
1.2	Dry packing of bricks for outer skin done correctly	4				
1.3	Dry packing of bricks for inner skin done correctly	4				
1.4	Wall ties placed correctly	4				
1.5	DPC inserted in the correct place for weeping holes	4				
					TOTAL MARK OUT OF 20	

It is recommended that video clips and photos of the learner performing the task be kept electronically at the school and on a disc (backup).

Figure 1 (left) and Figure 2 (right): Thirty-two (32) student teachers were given the activity to determine if it enhances critical thinking skills by using Facione's elements of critical thinking [13].

Table 1 below lists their responses.

Table 1: Student teachers' views on their analysis of phase 1 for Civil Technology PAT.

Concerns	Agree	Do not know	Disagree	Total
1. Interpretation: are learners able to understand what is required of them?	32 (100%)	-	-	32 (100%)
2. Analysis: will the task allow learners to bring different ideas in which the practical task can be carried out?	-	1 (3%)	31 (97%)	32 (100%)
3. Evaluation: are they given a chance to test different solutions against each other to select the best solution?	7 (22%)	1 (3%)	24 (75%)	32 (100%)
4. Inference: does it provide opportunity where learners may be able to see where they would use this skill in future (in the global community)?	13 (41%)	-	19 (59%)	32 (100%)
5. Explanation: does the task provide opportunity for learners to understand why they followed the steps for executing the task?	32 (100%)	-	-	32 (100%)
6. Self-regulating: does it provide opportunity for learners to re-do the task without the help of written instructions or of their teacher?	12 (37%)	6 (19%)	14 (44%)	32 (100%)

Indicated in Table 1 is that most student teachers disagree with the thesis that the Civil Technology PAT phase 1 for the construction specialisation enhances critical thinking skills with respect to analysis, evaluation, inference and self-regulation. This indicates that student teachers are aware the traditional pedagogy method is *demonstration and follow* and that it does not encourage critical thinking skills.

It should be noted that the aim of the present technology education curriculum in South Africa is to equip learners with problem-solving abilities, adaptability, innovativeness, creativity and hands-on skills paramount for technological literacy. Clearly, according to the student teachers, the Civil Technology practical assessment task does not encourage critical thinking skills.

DISCUSSSION AND CONCLUSION

According to Halpern critical thinking should promote creativity to come up with a creative solution to a problem and not be a case just of having new ideas [8]. Where new ideas are created, they should be useful and relevant to the task at hand. At least this is what should be reflected on practical tasks for Civil Technology. In fact, there is at present little or no faith in the ability of Civil Technology teachers to produce learners with good job attainment potential [22][23]. While this is problematic, it is also sad to note that the teaching resources given to Civil Technology teachers add to the problem.

To assist Civil Technology teachers and subject advisors on how to enhance critical thinking skills, it is recommended that the emphasis be reinstated on technological/design matters and be scenario-based. However, the way in which scenarios are formulated should not limit learners to one specific solution. This will enable factors, such as analysis, evaluation, inference and self-regulation to be covered on the PAT, to increase critical thinking skills.

Two scenarios are presented, to clarify how the PAT can enhance critical thinking.

Scenario 1

> *The Umfolozi River is one of the major rivers in northern KwaZulu Natal, which has very large catchments. The river flows continuously and with even short spells of rainfall in the catchments area the volume of flow increases significantly. During these times of rain, pupils from the surrounding communities attempting to across the river are unable to do so to attend school. Over the years many pupils and other community members have lost their lives while attempting to cross the river. Pupils lose many school days especially over the rainy season when the river levels are too high to cross. The closest alternative school is over 15 kms away. As this is a primary school, pupils as young as 6 years old are forced to cross this dangerous river without adult supervision. As a Civil Technology learner, you are required to design and make a bridge to solve this problem.* Courtesy of SANRAL.

Scenario 2

> *IKhwezi church is an old popular church in the village of Mkhondo. Everyone in that village attends that church and due to its popularity it is always full during Sunday services. This church is a hall-like structure surrounded by a piece of a land that is unused. The members of this church always complain about the noise made by the youth and Sunday school children during the pastors' sermons. As a Civil Technology learner you are required to solve this problem.*

Looking at scenario 1, it is clear that to solve the technological problem, learners are required to build a bridge. However, scenario 2 requires a learner to devise a solution that will not allow disturbance of church members by youth and Sunday school children. Scenario 2 may require a learner to think critically to solve this problem, while scenario 1 is limited to a bridge. Scenario 2 can have, but is not limited to, the following solution:

1. A learner redesigns the hall-like structure and allows for children, as well as youth to play in it.
2. Use a piece of surrounding unused land to create a playground for the youth and Sunday school children to play on during a church sermon, so they do not disturb the church members.

Scenario 2 gives room for creativity and innovation. The mere fact that it does not dictate a solution shows that learners may need to interpret the scenario, analyse it, evaluate it or draw inferences to explain why they think their solution is the best and self-regulate in devising a solution. These types of scenario would enable learners to develop the core skills of critical thinking.

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