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A Cognitive Stance to Enhance Learner Information Processing Ability in the Classroom: Structural Equation Modelling Approach

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Abstract

The purpose of this study is rooted within the post-positivist research paradigm and aimed at enhancing learner information processing ability in the classroom through the application of structural equation modelling (SEM) analysis. Despite previous years of good educational practice, it is evident from academic results that learners fail to engage in meaningful learning experiences in most South African classrooms. Solutions to teaching and learning problems in education today require a more sophisticated and complex approach. The dynamic merging of the fields of neuroscience, psychology, and pedagogy explores effective teaching and learning practices in light of current knowledge about the brain, learning processes, and factors that influence successful learning. This study employed a closed-ended questionnaire as the data collection instrument. The sample of the study included 650 Grade 11 learners that represented 20 schools of the 65 schools in the Fezile Dabi education district. Data gathered through a non-experimental quantitative design, following the survey method, was analysed through the application of inferential statistics. The main findings of the study illustrated a statistically significant relationship between the information processing ability of learners and conscious awareness, cognitive engagement, and metacognitive engagement. Teachers should take special interest in the study of the brain (i.e., from an educational-neuroscientific stance) because they should understand how the brain contributes to educational phenomena, such as learning, critical thinking, problem-solving, information processing and memory.

Keywords: brain-based education, cognitive processes, educational neuroscience, information processing, learning processes.

1. Introduction

Effective teaching requires teachers to take cognizance of how the brain processes information and how learning happens and are encouraged to deepen their knowledge in Mind, Brain and Education (MBE) science (Sarrasin et al., 2020). Furthermore, teachers must be efficacious to impact learning (Van der Merwe, 2013), which is strongly correlated with knowledge of the brain and memory systems. It may require teachers to have a scientific understanding of how learners learn and process information, where teachers are required to create engaging learning experiences that entail more art than science. In this vein, pedagogy refers to the art and science of teaching, where pedagogy serves as a cornerstone in which effective teaching regards instructional

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design and creating curricula that build on learners' previous knowledge and understanding to more metacognitive engagement (Bhowmik et al., 2013). Teachers must be the creators and transferors of enriched learning experiences, evident in teaching learning interactive environments (TLIE), where learners are metacognitively engaged in learning (Fourie, 2019).

It is evident from academic results that learners do not succeed in engaging and meaningful learning experiences in most South African classrooms. Education is not a 'one-size-fits-all' practice following a recipe approach. Teacher practices and learning approaches seem to fail the facilitation of learning and the transfer of learning across real-world contexts (Stenger, 2017). This could be partially attributed to the fact that teachers lack the necessary knowledge about the learning brain. Echoed by Whitman and Kelleher (2016), teacher quality is the most influential element of learner outcomes, and the application of a pedagogical approach informed by MBE sciences acts as the missing resource. The field of MBE science is directly aimed at how the human brain process information and provides some scientific insights into how the brain learns. There is a need to balance teaching and learning, and as Blakemore and Frith (2008: 118) explain, "We know a little of what goes on in the brain when we learn, but hardly anything about what goes on in the brain when we teach."

Teaching should be evidence-based and research-based, and he regards MBE sciences to be the most innovative thinking being applied towards the enhancement of teacher quality and student achievement today. According to Whitman and Kelleher (2016), teachers are brain changers. Teachers are indeed not neuroscientists, but they are surely regarded as brain changers since they are in one of the few professions that are responsible for changing the brain daily (i.e., learning). Furthermore, the teacher's conceptualization of knowledge greatly impacts his or her pedagogy, which in turn affects learners' epistemological beliefs (Lee et al., 2013). Limited integration and evidence of MBE sciences into teaching pedagogies exist. If teachers are expected to create engaging learning experiences for learners in effectively facilitating the transfer of learning, they should, perhaps, have a scientific understanding of how learners learn. If teachers do not understand how the brain is wired for learning, optimal pedagogies and teaching practices focussing on active learning and the transfer of learning across real-world contexts could be absent.

Voss, Thomas, Cisneros-Franco and de Villiers-Sidani (2017), similarly clarify that neuroplasticity is the brain's amazing capacity to change and adapt. It refers to the physiological changes in the brain that happen as the result of our interactions with our environment. From the time the brain begins to develop in utero until the day we die, the connections among the cells in our brains reorganise in response to our changing needs. This dynamic process allows us to learn from and adapt to different experiences. In the same vein, Shaffer (2012) indicates that neuroplasticity can be defined as the natural tendency of the brain architecture to shift in negative or positive directions in response to intrinsic and extrinsic influences. Strong connections exist between fluctuations of emotional states and brain functions. Inevitably, meaning is attached to the interrelatedness of neuroplasticity and positive psychology based on Shaffer's (2012) findings, where research on neuroplasticity considers the several ways in which positive psychologists can facilitate brain plasticity in a positive direction at any age.

Dehaene and Changeux (2011) claimed that "human cognitive neuroscience has made enormous strides in understanding the specific cerebral circuits underlying the particular domain of education, such as mathematics, reading, and language acquisition". Correspondingly, Galaburda (2011) states that "knowledge from neuroscience also lends itself to applications to education and I would hypothesize that the predictive value of neuroscience data to learning is opt to be greater than that of genetic data". Feist and Rosenberg (2012) explain that studies have indicated that learning and memory contribute to neuroplasticity, which in turn regards the significance of early brain structure and functioning development. Frith (in Lalancette, Campbell, 2012) further argues that educational neuroscience is evolving at the interface of neuroscience, cognitive sciences, and education. The authors argue that even if education focuses solely on enhancing learning and neurosciences solely on the brain mechanisms involved in learning, the future of education and the neurosciences are inextricably intertwined, and educational practices are being and will continue to be transformed by science.

Tandon and Singh (2015) indicate that two main streams of knowledge link neuroscience to education. The first knowledge stream claims that the brain structures are responsible for various educational processes like reading, attention, memory, calculation, and language acquisition. The second stream of knowledge regards the manner in which educational processes affect brain structure and function. Over the last few years, extensive research has demonstrated the role of these educational processes in learning, specifically in literacy and education. For instance, learning to read is also one of the most elegant examples of the neuroplasticity of the brain. While brain research may not yet tell us how to teach per se, it does inform teaching, learning, and school reform. We are at the beginning of a new vision in which scientists, educators, and hybrid educational neuroscientists can all work together toward school reform (Zadina, 2015). In order to be able to attend to the educational needs of the diverse groups of learners in modern society, Tandon and Singh (2015) indicate that teachers need to adjust their teaching knowledge from brain research.

Similarly, Jensen (2008) avows that understanding how the brain learns and applying relevant scientific insights and research about the brain is the single most powerful choice teachers can make to improve learning in the classroom. The aim of this study was to consider what research conceives of how efficient information processing (i.e., learning) could result in meaningful learning and understanding by the learner. Without focused attention and memory, there is no learning. The study further attempted to enhance learner information processing ability (IPA) in the classroom through the application of SEM analysis. Data gathered through a non-experimental quantitative design was analysed through the application of SEM. The study attempted to fill the existing gap in the scientific literature on how to enhance the IPA of learners by focusing on learner cognitive behaviours.

Theoretical Framework

The study encapsulated the theoretical framework of MBE science, which is regarded as the 'new' brain-based education. New and emerging research in neuroliteracy provides tremendous insight into how humans learn and subsequently how we should teach. The field of MBE science conspicuously informs teaching and learning practices and serves as a horizontal collaboration that integrates the work of clinicians, neuroscientists, and educators towards understanding aspects of memory, neuroplasticity, and how humans learn. MBE science initially integrated cognitive neuroscience and developmental psychology but then also incorporated education through educational psychology and educational neuroscience (Tokuhama-Espinosa, 2011a).

The MBE science framework was originally established by Tokuhama-Espinosa (2008) and introduced as the scientifically substantiated art of teaching. The fields of neuroscience (i.e., the brain and its functioning), psychology (i.e., the mind and behaviour), and education (teaching pedagogies) are scientifically brought together to inform teaching and learning from evidence-based practices (see Figure 1). In her article 'Why Mind, Brain, and Education Sciences is the "New" Brain-Based Education', Tokuhama-Espinosa (2011b) explained that MBE science is a paradigm shift in our understanding of the teaching profession.

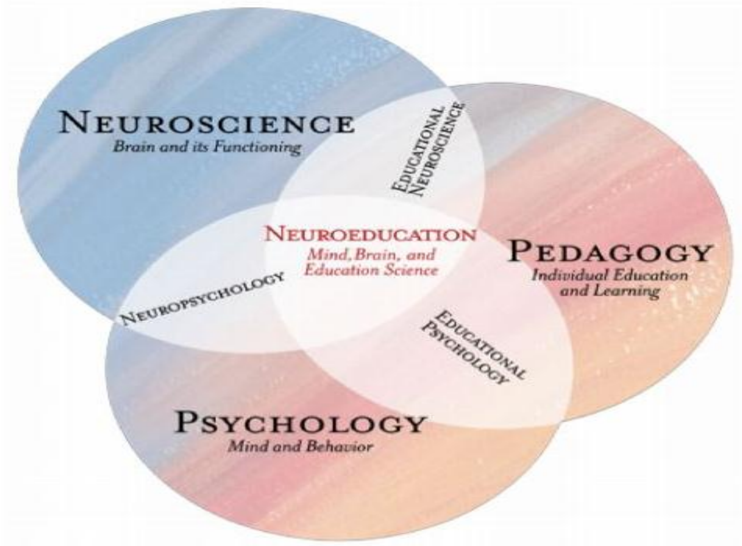

Fig. 1. The Scientifically Substantiated Art of Teaching (Adopted form Tokuhama-Espinosa, 2011b).

The transdisciplinary field of Mind (psychology), Brain (neuroscience), and Education (pedagogy) science deliberately seeks to enhance knowledge of the brain and how it learns. It also aims to inform pedagogical practices articulating the changing teacher profile in the 21st century that requires a new set of skills and improved knowledge of the human brain and underlying cognitive processes (Guerriero, 2017). The transdisciplinary nature of MBE is rooted in the origins of history, philosophy, and epistemology, becoming its own academic discipline (see Figure 2). The framework illustrates how learning sciences are encapsulated in the main disciplines (psychology, neuroscience, and education), and subsequently, each combination is an interdisciplinary field grounded in the history, philosophy, and epistemology of each. MBE science advocates that all three fields share an equal academic hierarchy, and the focus is not only on teaching or learning but rather on "the teaching-learning dynamic" (Tokuhama-Espinosa, 2017).

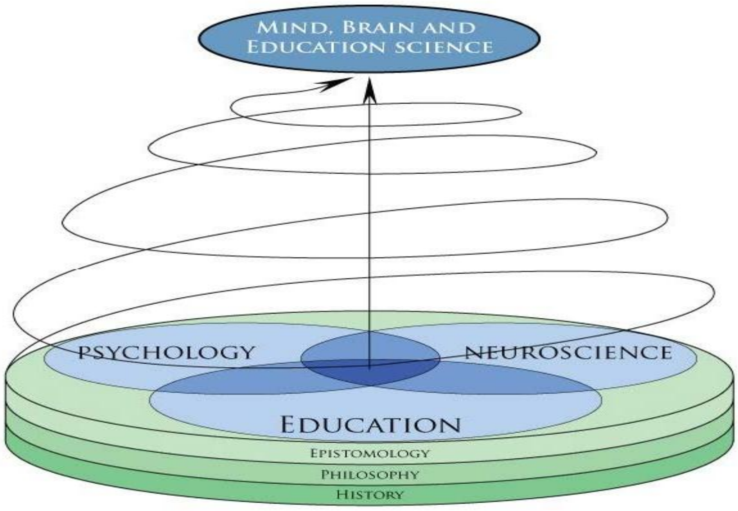

Fig. 2. The transdisciplinary nature of MBE Science

Canosa and Ruano (2019) explain that the transdisciplinary nature of MBE reflects the coordinated interaction between these disciplines, where knowledge is produced in a process of reciprocal learning without any hierarchy towards the resolution of certain complex problems. The main objective of a transdisciplinary approach is to achieve the unity and unification of knowledge. Lemon, Lambrechts, Fleming, and Lee (2016) point out that a key element of a transdisciplinary approach is that it provides a basis for critical reflection on research in education for sustainable development. This MBE transdisciplinary approach enables innovation to existing problems in education and offers evidence-based solutions for the classroom. Tokuhama-Espinosa (2011a) affirms that this vision encapsulates the different histories, philosophies, and epistemological lenses through which these shared problems in the separate fields are approached.

Samuels (2009, p. 46) contributes to the transdisciplinary nature of MBE by stating that "Transdisciplinarity is a perspective on knowledge creation that integrates disciplines at the level of a particular issue. It is an approach ideally suited for finding complex solutions to complex problems." The challenges that emanate from this approach are that new MBE professionals have to (i) accept the different historical roots of the three disciplines (neuroscience, psychology, and education), (ii) recognize the philosophies included through which each of these three disciplines views the world, and (iii) understand how these histories and philosophies explain and embrace different epistemologies (Tokuhama-Espinosa, 2011a). In precis, it is therefore essential to adopt thinking across academic disciplinary lines, merging understandings from different fields, to solve the complexity of the pedagogical challenges for teaching 21st-century skills.

Information processing ability of learners

Kim and Lee (2014) espouse the idea that it is more useful for learners to select knowledge and information by thought than to simply memorise what is provided to them. Learners should possess more than simply a quantity of knowledge (i.e., how much they know) but possess information-processing abilities instead (i.e., new knowledge can be constructed using existing information – this is ultimately what teachers should be developing in interactive teaching and learning environments).

Conscious awareness (CA) in the classroom

Kuldas et al. (2013) state a conscious learning process starts by deliberately paying attention to instructional materials, noticing similarities and differences between words and their particular meanings with the help of relevant prior experience, thereby mentally building coherent connections between them and organising them into new knowledge structures. Thus, either conscious or subconscious learning is primarily a combination of mental processes, referred to as a knowledge acquisition process, bringing memories into the mind, forming associations, retaining, and using them (Mayer, Moreno, 2003). Kuldas et al. (2013) uphold that the subconscious can conduce to the acquisition, access, and application of knowledge without deliberate and controlled attention. A permanent change in mental associations in long-term memory or a potential change in human behaviour is considered to be learning (Ormrod, 2008). Neuroscience is beginning to provide evidence for many principles of learning that have emerged from laboratory research. It shows how learning changes the physical structure of the brain and, with it, the functional organisation of the brain (Bransford et al., 2000).

Cognitive engagement (CE) in the classroom

Van Amburgh et al. (2007) postulate that the concept of learner engagement and active learning is becoming more than just educational rhetoric. Active learning techniques have emerged as strategies for teachers to promote engagement with both discipline material and learning. The next section focuses on metacognition, a strategy that refers to our knowledge about attention, recognition, encoding, storage, and retrieval and how these operations might be used to achieve a learning goal. Metacognitive knowledge develops with age, experience, and instruction and has a profound influence on classroom practices (Schneider, 2008). Effective teaching strategies must consider learners' stages of cognitive development, the status of their consciousness in learning, and their metacognitive ability awareness. Solis (2008) agrees that teachers need to teach for engagement, and from education literature, it becomes evident that learner engagement is a prerequisite of learning, and for learning to be truly meaningful, learners have to be cognitively engaged. Van Amburgh et al. (2007) postulate that the concept of learner engagement and active learning is becoming more than just educational rhetoric.

Metacognitive engagement (ME) in the classroom

Human learning is ultimately made possible through the information processing theory. Because of the information processed, higher-order thinking occurs, which involves metacognition. As Schneider (2008) explains, teachers need to understand the information-processing model to teach effectively for metacognitive awareness among learners. Research suggests that teachers have a significant role to play in raising learners' metacognitive awareness (Price-Mitchell, 2015). Cubukcu (2009) elaborates that researchers argue that the capacity to self-regulate is central to our assumptions about learning, decision-making, problem-solving, and resource management in education and that they are researching assessment instruments and intervention programmes to promote self-regulation and make learners use their metacognitive strategies.

2. Materials and methods

This study is ensconced within the post-positivist research paradigm. Data gathered through a non-experimental quantitative design, following the survey method, was analysed through the application of descriptive and inferential statistics. The latter inspired the authors to conduct a quantitative research study by employing inferential statistics to provide insights into the cognition of learners from a scientific stance. The target population comprises all the Grade 11 learners in the Fezile Dabi Education District of the Free State Province in South Africa. A probability sample for this study was selected through a multistage cluster-sampling procedure, which involves the selection of respondents in naturally occurring groups existing in two or more levels or clusters. Multistage sampling was conducted by selecting 20 schools (urban and rural) in the district during the first stage using stratified sampling. For each stratum, random sampling was used to select these 20 schools. In the second stage, 20 classrooms within schools were purposively selected where learners are taught in either Afrikaans or English. One class of Grade 11 learners were purposively selected per school. During stage three, a sample of convenience was used to select 840 learners representing the selected classes (± 42 learners in each class) to participate in the study.

The researchers included a big sample to account for possible dissimilarities in the target population and avoid the likelihood of a sample error. The study sample included 650 Grade 11 learners that represented 20 schools of the 65 schools in the Fezile Dabi education district. One statistic important to all research studies refers to the response rate (i.e., the number of individuals who responded to the questionnaire) divided by the total number of respondents to whom the questionnaire was administered. The response rate of the learners reported 77.4 % (650/840 x 100).

This study employed a closed-ended questionnaire as the data collection instrument. Section A consisted of 19 questions relevant to the demographic variables of the sample. Examples of items contained in this section refer to gender, race group, age, home language, and language of learning and teaching (LOLT), among others. Data was collected using nominal scales and reported in frequency tables and graphs. Section B consisted of 4 sub-sections, each containing a set of questions, preventing cognitive overload. In total, 75 questions were included. The response to each of these questions was sought on a four-point Likert-type scale ranging from Strongly Disagree (1), Disagree (2), Agree (3), to Strongly Agree (4) and contained items pertaining to the four dependent variables of the study.

The Likert-type scale is a popularly used multiple-item scale survey questionnaire that employs summated ratings to determine the strength of the attitude measured and attempts to quantify constructs, which are not directly measurable. The Likert-type scale items allowed for ease of access, reading, and responding. The data collection instrument was developed by the researchers through consultation with literature and experts in the field.

In this vein, the goal of measurement is to capture dependent variables with precision, sufficient variability, and sensitivity to proposed relationships and/or differences (Lee, Pickard, 2013). The validity and reliability of the measurement instruments influence the probability of obtaining statistical significance in the data analysis and the extent to which meaningful conclusions are drawn from the data (Tirivangana, 2013). Reports of validity and reliability estimates were necessary to determine the adequacy of the psychometric properties of the Likert-type questionnaire. Prior to analysis, the researcher conducted tests of the validity and reliability of the research instrument.

The face and content validity of the questions were tested by subjecting the questionnaire items to a panel of three judges and experts in the field to verify the validity. A pilot study was conducted prior to the research to further test validity and reliability. Furthermore, factor analysis was computed to obtain evidence of construct validity. Firstly, exploratory factor analysis (EFA) took a broad look at test data to determine how many underlying components were possible.

Secondly, confirmatory factor analysis (CFA) is a method used to test theoretical predictions about underlying variables or factors that make up a construct, and the process of CFA involved proposing underlying factors and then verifying their existence using statistical procedure of factor analysis. Criterion-related validity was not tested in this study. The Cronbach's alpha test which measures the internal consistency reliability of the research instrument for this study, was used as the reliability coefficient for the Likert-type scale in section B of the questionnaire. A Cronbach Alpha on each of the four dependent variables/constructs was calculated. The researchers also tested for inter-rater reliability by reporting the ICC statistic.

Research questions and hypotheses

The main research questions that guided the study refer to the opinions of learners, whether any relationship exists between conscious awareness, cognitive engagement, metacognitive engagement, and information processing ability and what role conscious awareness, cognitive engagement, and metacognitive engagement play in the IPA of learners in the classroom?

The structural equation modelling (SEM) research null hypothesis was formulated to answer these research questions: There is no statistically significant relationship between IPA, CA, CE, and ME.

SEM is a general statistical modelling and confirmatory technique used to delineate structural relationships among theoretical constructs (DVs) in that it tests – i) models that are conceptually derived and ii) if the theory fits the data. As part of the model specification, the exogenous (IVs) variables represented CA, CE, and ME, whilst the endogenous (DV) variable was IPA. The SEM analysis tested the theoretical (hypothesised/structural) model (i.e., the SEM null hypothesis) about the causal relationship between the DVs (IPA, CA, CE, and ME) as determined by the empirical data and measurement model.

Validity and reliability

Reports of validity and reliability estimates are necessary to determine the adequacy of the psychometric properties of the scales in a questionnaire. The information gathered for this study was done using a Likert-type scale questionnaire. Since it was attempted to quantify constructs that are not directly measurable, multiple-item scales and summated ratings were utilised to quantify the construct(s) of interest.

Exploratory factor analysis is employed when constructs are not directly measurable and simultaneously ensures the construct validity of the questionnaire. The constructs measured for this study (IPA, CA, CE, and ME) were extracted by employing exploratory factor analysis.

Exploratory Factor Analysis (EFA) for learners

As the first step, EFA was conducted on the data pertaining to learners. The sample size was deemed to be adequate (n=650) by referring to the Kaiser-Meier-Olkin (KMO) measure of sampling adequacy.

Table 1. KMO and Bartlett's test for learners

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	**0.966**
Bartlett's Test of Sphericity	
Approx. Chi-Square	26917.058
df	2775
Sig.	0.000

As deduced from Table 1, the correlation between variables is considered significant at $p < 0.05$ (0.001). Furthermore, the KMO measure of sampling adequacy of 0.966 indicates a sufficient sample size (KMO > 0.9 --> superb). Figure 3 displays the scree plot, indicating that four distinct factors loaded above an Eigenvalue of 1 were retained as part of the analysis and hypotheses testing. This implies that the four factors extracted by employing the Principal Component and the Direct Oblimin rotation method explained a total variance of 45.5% in the constructs or dependent variables.

The pattern matrix indicated the regression weight loading for each question (75 questions in total). The questions that loaded above a regression weight of 0.3 were retained. Out of the total of 75 questions, 9 questions loaded below 0.3 and were discarded. The EFA indicated that 12 questions loaded significantly for the dependent variable CE, 14 questions in total loaded significantly on CA, 25 questions loaded significantly on ME, and 15 questions loaded significantly on IPA.

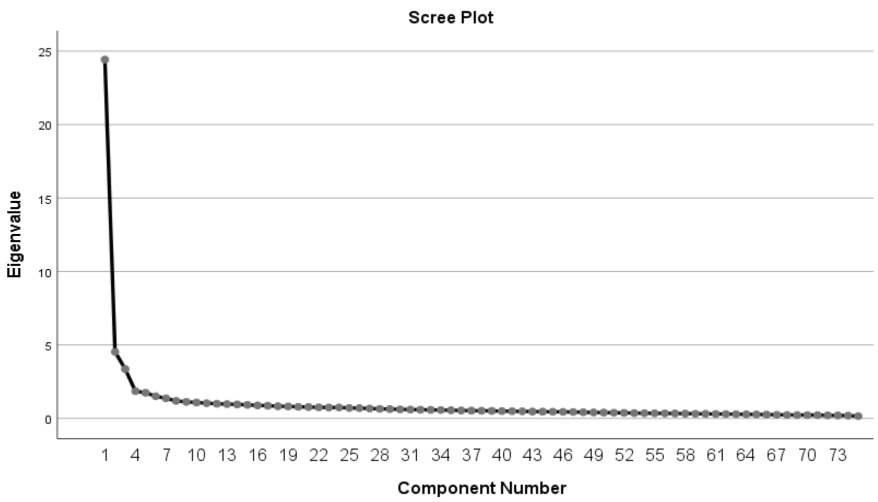

Fig. 3. Scree plot of Eigenvalues for learners

Reliability

Cronbach's alpha, which measures the internal consistency reliability of the research instrument for this study, was used as the reliability coefficient for the Likert-type scales. A Cronbach alpha coefficient was calculated on each construct to confirm their reliability in the local context. A Cronbach's alpha reliability coefficient usually ranges between 0 and 1. The closer Cronbach's alpha coefficient is to 1.0, the greater the internal consistency of the items in the scale. George and Mallery (2003) provide the following rule of thumb: _ > .9 – Excellent, _ > .8 – Good, _ > .7 – Acceptable, _ > .6 – Questionable, _ > .5 – Poor, and _ < .5 – Unacceptable.

As shown in Table 2, the Cronbach alpha for the DVs reported all above 0.8 and 0.9, indicating a good to excellent internal consistency.

Table 2. Cronbach alpha and ICC reliability coefficients for the dependent variables

Dependent variables	Cronbach alpha coefficient	Number of items tested
Cognitive Engagement (CE)	0.820	11
Conscious Awareness (CA)	0.897	14
Metacognitive engagement (ME)	0.940	25
Information Processing Ability (IPA)	0.939	15

Assumptions for statistical analysis

Garson (2012) asserts that all statistical procedures have underlying assumptions. An expected component of quantitative studies is to establish that the data of the study meet these assumptions of the procedure. Similarly, O'Neil (2009) outlines the importance of meeting the conditions of a particular statistical procedure before data analysis is done.

Normality

According to O'Neil (2009), it is assumed that the data gathered for statistical analysis is from a normally distributed population. As inferential statistics is done to verify that some or all of the results are applicable to the entire population, it is paramount that the population's distribution should also be normal. One instance which guarantees normality is when the distribution of the individual observations from the sample is normal. However, even if the distribution of the individual observations is not normal, the distribution of the *sample means* will be normal if the sample size is around 30 or larger. This is due to the 'central limit theorem' which posits that even when a population is non-normally distributed, the distribution of the *sample means* will be normal when the sample size is 30 or more. Since the sample size of this study was larger than 30 (N=650), the principle of normality of distribution was adapted.

Homoscedasticity

In statistics, the Levene's test is an inferential statistic used to assess the equality of variances for a variable calculated for two or more groups. Some common statistical procedures assume that variances of the populations from which different samples are drawn are equal. Levene's test assesses this assumption. It tests the null hypothesis that the population variances are equal (called homogeneity of variance or homoscedasticity). If the resulting p-value of Levene's test is less than some significance level (typically 0.05), the obtained differences in sample variances are unlikely to have occurred based on random sampling from a population with equal variances. Thus, the null hypothesis of equal variances is rejected, and it is concluded that there is a difference between the variances in the population. Homogeneity of variances (homoscedasticity) thus assumes that the dependent variables exhibit equal levels of variance across the range of predictor variables. Conversely, heteroscedasticity refers to a scenario where the variability of a variable is unequal across the range of values of a second variable that predicts it (Taylor, 2013). Table 3 indicates the descriptive statistics and tests conducted for homoscedasticity.

A Levene's test was conducted for each dependent variable. All the dependent variables were found to be *not statistically significant* (equal variances are assumed), since the p-value was in each case > (greater than) 0.05. Based on the above homogeneity of variances for each of the variables, the researchers accepted this statistical assumption met.

Table 3. Levene's test of homogeneity of variances for the dependent variables

Dependent variables	Levene Statistic	*df 1*	*df 2*	Sig.
For Learner data: Cognitive Engagement (CE)	.639	4	639	.635
Conscious Awareness (CA)	2.239	4	639	.063
Metacognitive engagement (ME	.606	4	639	.659
Information Processing Ability (IPA)	1.829	4	639	.122

Ethical clearance for the study was provided by the Faculty Research and Innovation Committee of the Faculty of Humanities.

3. Results

Structural Equation Modelling (SEM)

A SEM analysis was done on the data from learners to test the SEM null-hypothesis. Figure 4 and Table 4 display the results.

SEM Hypothesis There is no statistically significant relationship between **IPA, CA, CE,** and **ME.**

From Figure 4 and Table 4, all the regression weight estimates (i.e., path coefficients) are indicative of the amount (strength) of variance accounted for by each exogenous variable (i.e., IVs) on the endogenous variable (i.e., DV), meaning how strongly each exogenous variable influences the endogenous variable. The strength of these regression coefficients is reported as weak (.30), moderate (.50) and strong (.70) relative to the obtained ß weights. The statistical significance of these relationships between variables are also reported. As is evident from Table 4, these relationships between the four variables were found to all be statistically significant at $p < 0.05$ (0.001), where CA, CE, and ME were significant predictors of IPA:

CE <--- CA Standardised indirect coefficient =.533, p<0.05(0.001) was statistically significant.

ME<--- CA Standardised indirect coefficient = .586, p<0.05(0.001) was statistically significant.

IPA<--- CA Standardised direct coefficient = .310, p<0.05(0.001) was statistically significant.

IPA<--- ME Standardised indirect coefficient = .410, p<0.05(0.001) was statistically significant.

IPA<--- CE Standardised indirect coefficient = .150, p<0.05(0.001) was statistically significant.

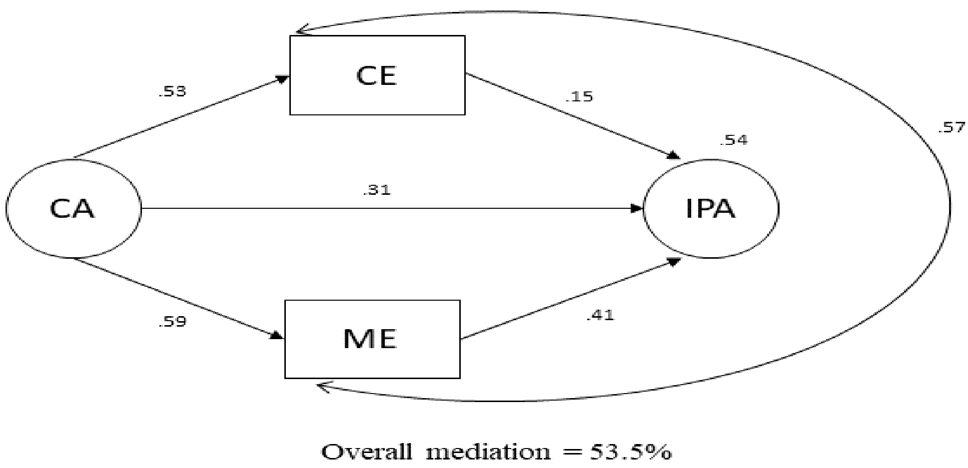

Fig. 4. SEM analysis on data from learners

Figure 4 claims that CA is a significant predictor ($p < 0.001$) of IPA (direct effect with a weak positive correlation of .31). CA is also positively correlated with ME (moderate to strong correlation of .59) and CE (moderate correlation of .53). There is a significant and strong combined mediation (indirect) effect evident for ME and CE on the direct effect of CA on IPA measured at 53.5 %. This implies that ME and CE (as mediator variables) also significantly affect IPA.

Baron and Kenny (1986) explain that a mediation model seeks to explain the relationship between an independent variable and a dependent variable via the inclusion of a third variable, known as a mediator variable. Rather than a direct causal relationship between the independent variable and the dependent variable, a mediation model proposes that the independent variable influences the mediator variable, which in turn influences the dependent variable. Thus, the mediator variable serves to clarify the nature of the relationship between the independent and dependent variables. However, the mediation effect of ME (.59 and .41) is stronger than the mediation effect of CE (.53 and .15) on IPA, as depicted in Figure 4.

Table 4. SEM analysis of data from learners (N = 650)

Variables	**Regression weight estimates**	**S.E.**	**Sig value p**	**Standardised Regression weight estimates**
CE <--- CA	.572	.064	0.001	.533
ME <--- CA	.723	.077	0.001	.586
IPA <--- CA	.400	.062	0.001	.310
IPA <--- ME	.429	.047	0.001	.410
IPA <--- CE	.181	.049	0.001	.150
CE <---> ME	.572	Correlation		
Overall mediation = .535				

Therefore, the SEM null hypothesis for learners is rejected as all these relationships are statistically significant.

4. Discussion

The main findings of the study illustrated that there is a statistically significant relationship between the IPA of learners and conscious awareness, cognitive engagement, and metacognitive engagement. The main research questions that guided the study refer to learners' opinions about whether any relationship exists between conscious awareness, cognitive engagement, metacognitive engagement, and IPA and what role conscious awareness, cognitive engagement, and metacognitive engagement play in the IPA of learners in the classroom.

As evidenced in Figure 4, the IPA of learners is directly and positively influenced by their conscious awareness (CA) in the classroom and was found to be statistically significant as calculated by the SEM analysis. The SEM analysis also illustrated that the relationship between CA and IPA is strongly mediated by CE and ME as predictor variables, where CA also strongly influences CE and ME, and CE and ME influence IPA. As deduced from the SEM analysis, there is a significant statistical relationship between these four DVs according to the learners. This implies that learners are of the opinion that their IPA is directly influenced and dependent on their conscious awareness, i.e., attention in the classroom. Learners are furthermore of the opinion that the relationship between their conscious awareness and IPA is mediated by their cognitive and metacognitive engagement in the classroom.

Bandura's social learning theory maintains that thought is influenced by internal processes involving attention, memory, and motivation, which might not be as readily observable as behaviour and its consequences (David, 2019). Latief and Dar (2014) explain that learning depends, in part, on the effective use of basic cognitive processes such as memory and attention, the activation of relevant background knowledge, and the deployment of cognitive strategies to achieve particular learning goals. Learning begins with attention; classroom attention could be cultured through active learning. The principles ensconced in MBE Science further confirm that attention is necessary during the learning process (Tokuhama-Espinosa, 2018). Through the findings of the SEM analysis conducted during this study, it was also found that attention, i.e., conscious awareness (CA), was necessary for learning, i.e., information processing (IPA).

However, principles of active learning remain a challenge for teachers in classrooms, and this study also attempted to outline these challenges by conducting an HLM analysis in which the influence of learner demographic variables (IVs) are explained to provide thoughtful insights for the creation of TLIE in South African schools. Against this backdrop, the results of learners and teachers in this study concur with assertions by David (2019) and Latief and Dar (2014). Solis (2008) agrees that teachers need to teach for engagement, and from education literature, it becomes evident that learner engagement is a prerequisite of learning, and for learning to be truly meaningful, learners have to be cognitively and metacognitively engaged through facilitated attention. The results further indicated that focused attention (i.e., conscious awareness) is indeed a vital cognitive behaviour necessary for learning. Ultimately, this study also intended to articulate the challenges facing education with regard to delivering educational professionals who are capable of inducing meaningful information processing by the learners during teaching.

5. Recommendations

The authors argue that the appropriate role of teachers is not to train learners in routine skills but to inspire and excite learners to new heights of creativity and imagination. The latter cannot be achieved through the sole humdrum of lesson presentation standing at the front of the classroom. Based on the stance mentioned above, the authors surmise that the most critical strategy, performances, and manoeuvres of a good and successful teacher regarding the ability to change and modify learners' behaviours to learn is embedded in the power of the teacher to regulate and order learners how to think, act, and behave (i.e., how to process information).

The teacher's ability to enable learners to receive, perceive, and manipulate the incoming information by either assimilation or accommodation in the cognitive schemata for deeper and broader knowledge that is meaningful and understandable is through the teacher's knowledgeability of the simultaneous impact of juxtaposed theories of learning to stimulate and cultivate learners' IPA. Teachers should take special interest in studying the brain (i.e., from an educational-neuroscientific stance), because they should understand how the brain contributes to educational phenomena, such as learning, critical thinking, problem-solving, information processing and memory. Teachers are indeed not neuroscientists, but they are members of the only profession in which their vocation is to change and transform the human brain daily.

In the process of teaching, it is imperative for teachers to encourage learners to ask questions, to analyse, to criticise, to compare and contrast, to wonder, and to become aware of alternatives. Certainly, learners' perceptions about themselves, their attitudes towards academic work, and their motivations influence their academic performance. Teachers should, therefore, also help learners analyse their own behaviour of processing information and evaluate their beliefs regarding their lifelong requirement to be consumers and manufacturers of knowledge bases that would mould their meaningful understanding of the elements or aspects of what constitutes life, living, and being assets through their mind/thinking.

Teachers should intentionally create a conducive and interactive teaching-learning environment in which learners can discover that their serious effort toward learning makes it possible for them to attain a sense of academic competence, which unconsciously modify the quality of their cognitive growth and development immeasurably. It is in this context that the research surmises that learners will immensely perceive the significance of the curriculum content incalculably.

Teachers should be subjected to periodic evaluation and accountability by departmental heads and or senior teachers for the depth and breadth of their learners' IPA, deducing from low achievement scores in assessments. Remediation by way of allowing a mentor assigned or chosen by the teacher can then be justified to train or advice on how to rouse and maintain IPA by the learners.

6. Limitations

This study was conducted in the field of educational psychology. It was confined in the Further Education and Training Phase (FET Grade 10-12) in the Fezile Dabi education district. The results of the study cannot, therefore, be extrapolated to both teachers and learners of Basic Education and those in tertiary institutions.

7. Declarations

Ethics approval and consent to participate

Ethics approval was granted by the Central University of Technology, South Africa, with informed consent from all participants.

Consent for publication

Not applicable.

Availability of data and materials

Please contact the author for data and materials associated with this study.

Conflict of interest statement

The authors of the manuscript declare that there is no conflict of interest, and all reference materials were duly acknowledged.

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