CONTRASTING MOTIVATION AND LEARNING STRATEGIES OF EX-MATHEMATICS AND EX-MATHEMATICAL LITERACY STUDENTS

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ABSTRACT

This inquiry contrasts motivation and learning strategies of ex-Mathematics (Maths) and ex-Mathematical Literacy (ML) students. ML ideally delivers candidates who can make sense of and actively participate in a world of numbers and numerical arguments, but ex-ML students are excluded from many undergraduate studies at most South African higher education institutions (HEIs). Institutions employ various strategies in enhancing student transition to higher education (HE), however, such options are rare for ex-ML students. A year-long foundation programme offered by a private HEI is one exception. This inquiry employed the Motivated Strategies for Learning Questionnaire and t-test, detecting significant differences in motivation and learning strategies between 111 ex-Maths and 81 ex-ML students. The intrinsic goal orientation, task value, self-efficacy, effort regulation and test anxiety-handling abilities of ex-Maths students were significantly superior. An integrated solution process addressing academic content and social-psychological attributes to improve the motivation of ex-ML students in support of their academic development is proffered.

Key words: Mathematical Literacy, student motivation, learning strategies, motivation and Strategies for Learning Questionnaire (MSLQ), self-regulated learning; foundation programme students

BACKGROUND, CONTEXT AND PURPOSE

Since 1998, when outcomes-based education (OBE) was introduced to South African schools,

learners have had the choice of selecting either Mathematics (Maths) or Mathematical Literacy (ML) from Grades 10 to 12. National Senior Certificate (NSC) Maths has paralleled its precursor (Engelbrecht and Harding 2008), by which previously learned foundations were developed in formal and symbolic ways, and general and abstract principles were applied to various contexts. The introduction of ML, by contrast, was underpinned by a philosophy of social justice (Bansilal 2014) such that the subject be considered independent from Maths rather than an alternative for "those who can't do Maths" (Houston et al. 2015; Venkatakrishnan and Graven 2006, 26). ML is the equivalent of the internationally known Quantitative Literacy, as both expect learners to make sense of contexts from a quantitative viewpoint (Bowie and Frith 2006).

While Maths learners are expected to engage in higher mental processes (DoE 2008), Houston et al. (2015) record, in contrast to their own view, that ML learners are largely believed to utilise lower level arithmetic thinking and computational skills in everyday contexts. They postulate that ML learners routinely employ higher cognitive skills, such as analysing, interpreting and drawing conclusions within the contexts they explore, whilst Venkat (2010) argues that the dual task of applying higher-level skills within life-related contexts may result in their not being able to present mathematical information logically or coherently; a skill required in Maths. Mhakure and Mokoena (2011) record substantial differences between the content covered in the Maths and ML curricula, with the former explicitly outlining the expected mathematical development in the learning outcomes from Grade 10 through to Grade 12, and progression in the latter (Venkat 2010) is not overt through the grades. The result is ensuing career choices and study directions that are considered divergent (DoE 2003).

With such contrasting mathematical backgrounds, one may postulate that differences in the motivation and learning styles of ex-Maths or ex-ML students would be apparent. The contribution of self-regulated learning components, in particular motivation and learning strategies, are directly and indirectly linked to academic achievement (Mega, Ronconi and De Beni 2013; Yusuf 2011) and it is these variables that discriminate strongly between successful and less successful students commencing their higher education (HE) studies (Smith 2012). As a result, higher education institutions (HEIs) employ strategies to enhance student transition to the sector and improve performance, including academic development programmes (Smith 2012) and foundation programmes (Wood and Lithauer 2005), in which ex-ML students often begin their HE studies, as ML is not considered an appropriate subject for entrance to select undergraduate degrees (Van der Westhuizen and Barlow-Jones 2015). Even so, few HEIs present such alternative offerings to ex-ML students and hence the opportunity to research self-regulated learning and/or the academic success of these students is often not feasible. Apart

from Baumgartner (2016) and Spangenberg (2012), who explored the motivational and learning strategies, as well as the thinking styles of ML learners, no known South African studies have interrogated the self-regulated learning of ex-ML students. An understanding of the extent to which students of ML and Maths exhibit similarities and differences in respect of their motivation and learning strategies provides an opportunity to explore academic development activities and plans that might impact positively on the motivation and eventually also the academic achievement of the former group. This article endeavours to enhance the learning and motivational strategies of Mathematical Literacy learners, hopefully enabling more of them to successfully articulate to a broader spectrum of HE programmes in future.

LITERATURE PERSPECTIVES

Main theoretical underpinnings

Motivation and learning strategies are two central constructs within self-regulated learning (SRL) theories, which are fundamental in the study of student academic achievement (Zimmerman 1986). Studies directed toward SRL in education began in the 1960s and 1970s (Bandura 1977; Zimmerman 1973) and gained momentum through the 1980s (Schunk 1984; Zimmerman 1986; Zimmerman and Pons 1986), during which time researchers attempted to develop theories and create models (Bandura 1977; Zimmerman 1986). The resulting instruments (Pintrich et al. 1991) have become pivotal in research relating to SRL and student academic achievement (Eum and Rice 2011; Van Zyl, Gravett and De Bruin 2012).

While SRL developed from a social cognitive perspective (Bandura 1977) the theory also has foundations within Vygotsky's social constructivist paradigm (Tanriseven and Dilmaç 2013). Zimmerman (1986, 307) suggests a renewed philosophical assumption based on student-centred, rather than teacher-centred learning, since SRL considers "*how* students personally activate, alter, and sustain their learning practices in specific contexts". Other elements of social constructivism explicit within SRL include the expectation that it is the learner who will make an effort to reconstruct knowledge and meaning. Such exertion requires a level of motivation and Stroet, Opdenakker and Minnaert (2016) catalogue studies reporting the positive relationship between social constructivist learning environments and higher levels of student motivation.

Wigfield and Eccles (2000) connect motivation and learning strategies, since student beliefs influence perseverance (Tanriseven and Dilmaç 2013). Additionally, learning strategies, such as seeking help from a More Knowledgeable Other (MKO) improve the construction of individual knowledge and expand the Zone of Proximal Development (ZPD) (Vygotsky 1978).

SRL theorists generally agree that students who harness SRL are actively and constructively involved in "a process of meaning generation and that they adapt their thoughts, feelings, and actions as needed to affect their learning and motivation" (Boekaerts and Corno 2005, 201).

The ensuing study has been developed from the main theoretical underpinnings of Bandura's (1977) social cognitive perspectives on SRL and Vygotsky's (1978) MKO and ZPD theories. The former postulates motivation to be "primarily concerned with activation and persistence of behaviour" (Bandura 1977, 193), and learning strategies that involve "cognitive engagement and processing ... to learn the material in a more disciplined and thoughtful manner, ... integrating the new material with previously held conceptions of the content" (Pintrich and Zusho 2007, 737). Vygotsky's (1978) social constructivist theory advocates that "activities that are within the individual's zone of proximal development will stimulate the greatest intrinsic motivation", (Ciampa 2013, 82). This study, which contrasts the motivation and learning strategies of ex-Maths and ex-ML students, takes cognisance of SRL within both these frameworks.

Self-regulated learning

SRL is an active self-directive *process* through which students transform their mental abilities into task-related academic skills (Boekaerts and Corno 2005; Zimmerman 2008) according to their personal prerequisites for motivation and learning. This process is cyclical, involving four phases, *viz.* planning, monitoring, controlling and reflecting (Pintrich 2000) and comprises cognitive strategies and effort (Yunus, Suraya and Wan Ali 2009). Cognitive strategies include organisation skills, goal-setting, effective work strategies, and time and resource management (Velayutham and Aldridge 2012). SRL is thus a proactive learning experience rather than a consequence of teaching. SRL students "personally initiate and direct their own efforts to acquire knowledge and skill", rather than only relying on an MKO and demonstrate the use of "self-regulated learning strategies, self-efficacy perceptions of performance skill and commitment to academic goals" (Zimmerman 1989, 329).

Since the 1980s, research designed to understand and explain students' SRL as related to themes such as academic studying, learning strategies, intrinsic motivation and meta-cognitive engagements has flourished (Zimmerman 1989). Studies such as that of Zimmerman (1989, 337. employ a social cognitive approach that specifically links "self-regulatory processes to specific social learning" and identify self-efficacy perceptions and strategy use as "two key processes through which self-regulated learning is achieved" linking this to student motivation and achievement, with consideration to informing interventions. Pintrich (2000) concurs that SRL requires elements of motivation and learning strategies such as effort regulation, to ensure

successful task completion. As such, a more thorough consideration of motivation and learning strategies is warranted, as these may be two vital components of SRL that form part of the requirements for students to achieve academic success.

Motivation and learning strategies

Researchers (Boekaerts and Corno 2005; Matuga 2009; Pintrich 2000; Tanriseven and Dilmaç 2013) agree that motivation and learning strategies are core components of SRL. Motivation theories encompass the achievement of goals, intrinsic motivation, self-efficacy and the control of learning beliefs (Pintrich 2000), in addition to expectation value or extrinsic motivation (Tanriseven and Dilmaç 2013). As such, there are numerous variables that comprise and impact student motivation. Matuga (2009, 5) regards learning strategies as including "the ability of students to plan, monitor and evaluate their own behaviour, cognition and learning strategies". Students will apply these strategies according to their perceived knowledge and skill acquisition value (Zimmerman 1989) and those who are motivated and apply self-regulated learning strategies in their mathematics studies are likely to attain academic achievement. Those who consider motivation and learning strategies are thus crucial to determine which factors are important predictors of SRL and which may require a strategic intervention to better equip them in their undergraduate studies.

Pintrich et al. (1991) consider six elements of motivation. *Intrinsic Goal Orientation* (IGO) encompasses "challenge, curiosity, mastery" as reasons to engage in a task as an end in itself (Pintrich et al. 1991, 12), while *Extrinsic Goal Orientation* (EGO) refers to rewards or competition, in which a task is considered a means to an end. *Task Value* (TV) encapsulates the expected importance and usefulness of a task, while *Control of Learning Beliefs* (CoLB) describes the belief the students hold that their learning efforts will result in positive outcomes. *Self-Efficacy for Learning and Performance* (SELP) comprises two aspects: "expectancy for success", which relates to performance, and self-appraisal or the belief in one's ability or skill to perform the task (Pintrich et al. 1991, 13). Finally, *Test Anxiety* (TAnx) is inversely correlated to learning and performance.

Matuga (2009, 5) explains learning strategies as "the ability of students to plan, monitor and evaluate their own behaviour, cognition and learning strategies", whilst Pintrich et al. (1991) put forward nine attributes of learning strategies. The four cognitive strategies include *Rehearsal* (Reh), which includes repetition, *Elaboration* (Elab), which incorporates summarising and paraphrasing, *Organising* (Org), which involves sorting information, and *Critical Thinking* (CT), which develops higher order activities such as reflection, decision-making and synthesis. *Metacognitive Self-Regulation* (MSR) strategies refer to awareness and

control of cognition through the process of upfront planning, monitoring throughout the process and regulating cognitive strategies in need. Resource management includes *Time and Study Environment* (TSE) to planning one's time, and class attendance effectively, while *Effort Regulation* (ER) reflects the ability to manage commitments to attaining the goal of task completion. *Peer Learning* (PeerL) is the ability to work cooperatively with others engaged in the task, while *Help Seeking* (HelpS) is the ability to request and harness assistance for others, including teachers.

Motivation and learning strategies, as multidimensional constructs, have been studied in various settings across differentiated samples (Chyung, Moll and Berg 2010; Coutinho and Neuman 2008; Credé and Phillips 2011; Jain and Dowson 2009; Jungert and Rosander 2010; Liu and Lin 2010; Payne and Israel 2010; Prat-Sala and Redford 2010). The researchers conclude that one or more of the 15 motivation and learning strategy attributes previously outlined are key attributes for student academic achievement. Results collectively and comprehensively support the connection between attributes of motivation and/or learning strategies, although there is a lack of clarity on which of these are most vital for successful SRL. Many studies (Liu and Lin 2010; Payne and Israel 2010; Pintrich et al. 1993; Tuan, Chin and Shieh 2005) interrogating the role of motivation and learning strategies in student academic achievement have employed the Motivated Strategies for Learning Questionnaire (MSLQ) which was developed from a social-cognitive viewpoint (Duncan and McKeachie 2005). Further research relating to motivation, learning strategies and SRL, specifically using the MSLQ in the South African HE context, is thus regarded as opportune and necessary.

RESEARCH DESIGN AND METHODOLOGY

Empirical context, purpose and participants

This study was undertaken at a private HEI in South Africa where, in addition to customary undergraduate and postgraduate offerings, a one-year FP is accessible to students who do not gain direct access to undergraduate studies. Students in the FP must study and pass eight courses, of which two are Mathematics A and Mathematics B, if they envisage to enrol for the Bachelor of Business (BBus) degree. Prior results, however, indicate that ex-ML students struggle to pass the FP's Mathematics A course in particular. Students who do not pass that course and complete the FP are not permitted to enrol in undergraduate studies.

In February 2014, 482 students enrolled in the FP Mathematics A course were selected to voluntarily participate during their third lecture period by completing the MSLQ. Ethical clearance to conduct the study had already been granted by the institutions involved and this

was adhered to. Completed questionnaires were returned by 419 students, resulting in an overall 86.9 per cent realisation rate. Data was sub-divided according to participants' prior mathematical background: Maths, ML and other school-level mathematical curricula. From these segments, 201 participants passed either Maths or ML in Grade 12 and were aiming to enrol for the BBus degree upon completing the FP. Nine of these 201 questionnaires were incomplete and thus excluded, resulting in the sample for the study: Maths ($n = 111$) and ML ($n = 81$). An analysis of the biographical data elucidated that 40.2 per cent of the male participants and 44.7 per cent of female participants were ex-ML students. The majority of both Maths (66.7%) and ML (72.8%), comprising a total of 69.3 per cent, were defined as black South Africans. Most participants, 70.8 per cent, had completed their secondary schooling the previous year.

The data collection instrument

The purpose of the MSLQ is to create a general model (Artino 2005) to understand the motivation and learning strategies of students in higher education in order to assist students to develop their learning orientation and strategies. This 81 item Likert scale questionnaire, with seven possible answers from 1 ("not at all true of me") to 7 ("very true of me") was developed and tested by Pintrich et al. (1991) and has undergone validity and reliability testing in three languages showing sound, albeit moderate, predictive validity (Artino 2005). The self-report questionnaire was designed to measure motivation and learning strategies according to 15 subscales as they relate to a specific course, rather than general learning. As an appropriate instrument of choice for this study, permission from the authors was sought and granted to employ the MSLQ. Table 1 displays the motivation section first, which contains 31 items allocated to six subscales, namely intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance and test anxiety. The 50 items included in the nine subscales apportioned to strategies for learning are depicted next. These subscales consider cognitive and metacognitive strategies as well as management of resources.

Data capturing and processing

The MSLQ responses were captured onto an *Excel* spreadsheet and exported to the Statistical Package for Social Sciences (SPSS) version 23 for detailed analysis using inferential statistics. The data was analysed according to the responses of the two groups of students (Maths and ML) for motivation and learning strategies and are reported in this way.

Table 1: The structure and nature of the MSLQ

Category	Component	Subscale	Number of items
Motivation	Value	Intrinsic goal orientation (IGO)	4
		Extrinsic goal orientation (EGO)	4
		Task value (TV)	6
	Expectancy	Control of learning beliefs (CoLB)	4
		Self-efficacy for learning & performance (SELP)	8
	Affective	Test anxiety (TA)	5
Strategies for learning	Cognitive and meta-cognitive strategies	Rehearsal (Reh)	4
		Elaboration (Elab)	6
		Organisation (Org)	4
		Critical thinking (CT)	5
		Metacognitive self-regulation (MSR)	12
	Resource management	Time/study environmental management (TSE)	8
		Effort regulation (ER)	4
		Peer learning (PL)	3
		Help seeking (HS)	4

Validity and reliability measures

Cronbach's alpha coefficient domains of the MSLQ subscales were calculated to determine reliability (Pallant 2007). Due to the low number of items in many subscales, inter-item correlation means were also calculated (Briggs and Cheek 1986; Pallant 2007). Table 2 presents these reliability values, in addition to the means and standard deviations for both groups in the sample. The alpha coefficients for Pintrich et al.'s (1991) original study are presented in parentheses to provide a contextual comparison.

Internal consistency was established for 14 of the subscales, through a Cronbach's alpha coefficient of at least .7, and/or inter-item coefficient means of between .2 and .4 as highlighted in Table 2. These 14 subscales were included in the subsequent analysis. The *CoLB* subscale was briefly interrogated. The four items contained two positive and two negative statements and all provided "if ..., then ..." consequential dilemmas or responsibilities, such as "It is my own fault if ...". Participants may have responded differently to individual items in this subscale based on these differences, thereby contributing to the lack of reliability. This subscale was therefore discarded from further analysis.

Validity aims to ensure the research measured what it proposed to measure (Koonin 2014). Prior studies, including those undertaken in South Africa (Payne and Israel 2010) and in the domain of mathematics (Liu and Lin 2010; Mendelsohn 2015), were determined to be sufficient as an indicator that the instrument itself would withstand sound factor validity (Pintrich et al. 1993). Using the data originally gathered from all 419 participants, all but three of the 15 subscales were confirmed by exploratory factor analysis. Metacognitive self-regulation was

reduced to three factors, time and study environment regulation items were reduced to two factors and effort regulation items delivered two categories. Nevertheless, the 14 subscales that revealed internal consistency were assumed to have acceptable factor validity and were analysed further based on this assumption.

Table 2: Sample statistics on the fifteen MSLQ subscales

MSLQ subscale and number of items	Cronbach's alpha	Inter-item correlation	Cohort:	Mean	Std. deviation
Intrinsic goal orientation (IGO) [4]	0.62 (.74)	0.29	Maths *	4.93	1.12
			ML **	4.56	1.11
Extrinsic goal orientation (EGO) [4]	0.57 (.62)	0.26	Maths	6.01	0.86
			ML	5.94	0.97
Task value (TV) [6]	0.80 (.90)	0.39	Maths	5.45	1.01
			ML	4.89	1.08
Control of learning beliefs (CoLB) [4]	0.42 (.68)	0.17	Maths	5.44	0.86
			ML	5.46	0.92
Self-efficacy for learning & performance (SELP) [8]	0.87 (.93)	0.45	Maths	5.48	0.88
			ML	4.68	1.07
Test anxiety (TAnx) [5]	0.77 (.80)	0.39	Maths	4.24	1.39
			ML	4.81	1.36
Rehearsal (Reh) [4]	0.59 (.69)	0.26	Maths	4.70	1.15
			ML	4.80	1.09
Elaboration (Elab) [6]	0.73 (.76)	0.31	Maths	5.78	1.28
			ML	5.72	1.14
Organisation (Org) [4]	0.62 (.64)	0.29	Maths	4.77	1.14
			ML	4.72	1.09
Critical thinking (CT) [5]	0.69 (.80)	0.30	Maths	4.33	1.10
			ML	4.36	1.03
Metacognitive self-regulation (MSR) [12]	0.70 (.79)	0.17	Maths	4.72	0.75
			ML	4.63	0.86
Time study environment (TSE) [8]	0.68 (.76)	0.21	Maths	4.88	0.91
			ML	4.78	0.86
Effort regulation (ER) [4]	0.58 (.69)	0.25	Maths	5.02	1.09
			ML	4.65	1.09
Peer learning (PeerL) [3]	0.67 (.76)	0.39	Maths	3.86	1.50
			ML	3.85	1.39
Help seeking (HelpS) [4]	0.50 (.52)	0.20	Maths	4.28	1.18
			ML	4.35	1.10

*Maths: n = 111; **ML: n = 81

FINDINGS AND DISCUSSION

Normality of the data and selection of the statistical test

The Shapiro-Wilks W test (n < 2,000) was employed to determine normality of the data for each subscale (Pallant 2007). The data generated a significant finding ($p < .005$) for five subscales, *viz.* extrinsic goal orientation, task value, self-efficacy for learning and performance, time and study environment and effort regulation. As such, a normal distribution could not be

assumed for this data (Pallant 2007). Consequently, the data on nine of the subscales was normally distributed. The sample size was, however, moderately large (*n* close to 200), and an interrogation of the Q-Q plots and stem-and-leaf plots distributions (supported by the Cross Validated website of StackExchange (2016)) led the authors to employ the Student's t-test with sufficient caution.

Testing for significant differences

The results of the t-tests are reported in Table 3.

Table 3: Independent samples t-test: Comparison of Maths and ML results

MSLQ Subscale		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
IGO	EVA	.008	.93	2.35	190	.020	.37	.16	.059	.68
	EVNA			2.33	168	.021	.37	.16	.057	.68
EGO	EVA	.77	.38	.49	190	.63	.065	.13	-.20	.33
	EVNA			.48	160	.63	.065	.14	-.20	.33
TV	EVA	.55	.46	3.70	190	.000	.56	.15	.26	.86
	EVNA			3.66	165	.000	.56	.15	.26	.86
SELP	EVA	2.63	.12	5.61	190	.000	.79	.14	.51	1.07
	EVNA			5.45	152	.000	.79	.15	.50	1.08
TAnx	EVA	.50	.48	-2.86	190	.005	-.58	.20	-.97	-.18
	EVNA			-2.88	175	.005	-.58	.20	-.97	-.18
Reh	EVA	.85	.36	-.57	190	.57	-.094	.16	-.42	.23
	EVNA			-.57	178	.57	-.094	.16	-.42	.23
Elab	EVA	.84	.36	.34	190	.74	.061	.18	-.29	.41
	EVNA			.35	183	.73	.061	.18	-.29	.41
Org	EVA	.90	.35	.33	190	.74	.054	.16	-.27	.38
	EVNA			.34	177	.74	.054	.16	-.27	.37
CT	EVA	.49	.49	-.17	190	.87	-.027	.16	-.34	.28
	EVNA			-.17	179	.87	-.027	.16	-.33	.28
MSR	EVA	.64	.43	.85	190	.40	.099	.12	-.13	.33
	EVNA			.84	158	.41	.099	.12	-.14	.33
TSE	EVA	1.92	.17	.72	190	.47	.094	.13	-.16	.35
	EVNA			.73	178	.47	.094	.13	-.16	.35
ER	EVA	.053	.82	2.38	190	.018	.38	.16	.065	.69
	EVNA			2.38	172	.018	.38	.16	.065	.69
PeerL	EVA	.76	.38	.019	190	.99	.004	.21	-.42	.42
	EVNA			.019	180	.99	.004	.21	-.41	.42
HelpS	EVA	.22	.64	-.387	190	.70	-065	.17	-.40	.27
	EVNA			-.392	179	.70	-.065	.17	-.39	.26

IGO = Intrinsic goal orientation   **Org** = Organisation
EGO = Extrinsic goal orientation   **CT** = Critical thinking
TV = Task value   **MSR** = Metacognitive self-regulation
CoLB = Control of learning beliefs   **TSE** = Time and study environment
SELP = Self-efficacy for learning and performance   **ER** = Effort regulation
TAnx = Test anxiety   **PeerL** = Peer learning
Reh = Rehearsal   **HelpS** = Help seeking
Elab = Elaboration
EVA = Equal variances assumed   **EVNA** = Equal variances not assumed

From the t-test results, the Levene's test for equality of variance returned a decision that equal variances should be assumed for every subscale (Pallant 2007). The sample comparisons for each of the 14 subscales are thus presented. The subscales showing contrasting data between the two groups are expounded first.

The mean *Intrinsic Goal Orientation* (IGO) of FP ex-Maths students ($M = 4.93$, $SD = 1.12$) is *significantly higher* than the mean IGO of FP ex-ML students ($M = 4.56$, $SD = 1.11$), $t(190) = 2.35$, $p < .05$, $d = .33$. The Cohen's d effect size of .33 indicates that this finding has relatively small to moderate practical significance (Cohen 1992; Pallant 2007). Studies that may be considered alongside this result include Chyung, Moll and Berg's (2010) outcome that IGO is significant as a learning predictor in Engineering studies, Tanriseven and Dilmaç's (2013, 34) conclusion that "motivational beliefs are the resources that motivate learners to use learning strategies" and Eum and Rice's (2011) determination that students who are intrinsically motivated are less likely to experience test anxiety than those who are extrinsically motivated. Based on these observations, admission of ex-ML students to an FP should be considered in a cautionary manner, as their lower IGO score may indicate that their learning strategies are inferior to those of other students.

In terms of *Task Value* (TV), again the ex-Maths students' mean result ($M = 5.45$, $SD = 1.01$) was *significantly higher* than that of the ex-ML students ($M = 4.89$, $SD = 1.08$), $t(190) = 3.70$, $p < .05$, $d = .26$. Once more, the Cohen's d effect size of .26 had relatively small practical significance. These findings, in conjunction with Velayutham and Aldridge's (2012) results that task value in Science classrooms is a strong predictor of self-regulation, should alert ex-ML students (and their FP facilitators) to their lower reported perceptions of task value might negatively impact on their self-regulated learning abilities.

Coutinho and Neuman (2008) find self-efficacy to be the strongest predictor of performance in their study and Yunus, Suraya and Wan Ali (2009, 99) concur: "self-efficacy has a high positive correlation with test performance outcomes" and thus academic achievement. In this study, the mean *Self-Efficacy for Learning and Performance* (SELP) of ex-Maths students ($M = 5.48$, $SD = 0.88$) is *significantly higher* than that of ex-ML students ($M = 4.68$, $SD = 1.07$), $t(190) = 5.61$, $p < .05$, $d = .38$. Once more, the Cohen's d effect size of .38 indicates that this finding has small to moderate practical significance. If Coutinho and Neuman (2008) and Yunus, Suraya and Wan Ali (2009) are correct, the findings from this study suggest that ex-ML students entering a FP may not have the self-efficacy to be able to perform academically at the same academic level as ex-Maths counterparts.

Contrary to prior findings, the mean *Test Anxiety* (TAnx) of ex-Maths students ($M = 4.24$,

$SD = 1.39$) is *significantly lower* than that of ex-ML students ($M = 4.81$, $SD = 1.36$), t (190) = -2.86, $p < .05$, $d = .20$, although again, the Cohen's d effect size of .20 indicates that the practical significance of this finding is small. The consequence of this result was considered alongside findings of Eum and Rice (2011), that higher levels of TAnx lead to lower academic achievement, of Matuga (2009), who postulates that higher achievements lead to higher levels of motivation and of Jain and Dowson's (2009) negative correlation between mathematics anxiety and both self-efficacy and self-regulation. Their higher levels of test anxiety may negatively impact on the academic achievement of ex-ML students in the FP relative to that of other students.

Finally, the mean *Effort Regulation* (ER) ascribed to ex-Maths students ($M = 5.02$, $SD = 1.09$) is *significantly higher* than that of ex-ML students in the FP ($M = 4.65$, $SD = 1.09$), t (190) = 2.38, $p < .05$, $d = .17$. The Cohen's d effect size of .17 indicates that this finding too has small practical significance. Again, this may be troublesome for ex-ML students when taking into account the findings of Credé and Phillips (2011), as they observe the strongest correlation of all MSLQ subscales between ER and academic achievement, and ex-ML students' results are significantly lower than those of ex-Maths students. As such, the lower effort regulation that may be exhibited by ex-ML students in the FP may imply that their academic achievement could lead to results that are lower than those of their ex-Maths counterparts.

The t-test findings thus indicate a *significant difference* in the mean scores between the two groups in respect of five subscales of the MSLQ, namely *intrinsic goal orientation, task value, self-efficacy for learning and performance, test anxiety* and *effort regulation* which are supported by prior findings of Baumgartner, Spangenberg and Jacobs (2014). While the differences are significant, the Cohen's d effect size records small to moderate practical significance for these subscales as reported previously. The combined findings reported from prior studies relating to these findings may provide a basis for concern when considering the reinforcing links between the five subscales and resulting potential academic achievement of ex-ML students in the FP. If there are strong relationships between IGO and TAnx (Eum and Rice 2011) TV and self-regulation (Velayutham and Aldridge 2012) and self-efficacy, self-regulation and TAnx (Jain and Dowson 2009), it seems that a strategy to improve academic achievement by addressing one of these subscales may simultaneously positively influence other subscales.

The data from the remaining subscales was then interrogated. Seven subscales, namely *rehearsal, elaboration, organisation, critical thinking*, *metacognitive self-regulation*, *peer learning* and *help seeking* were normally distributed, although no significant differences were found between the two groups. As such, these subscales appear to reflect similarities between

the two groups. While it is encouraging to find as evidence this many similarities between the two groups, the greater concern is that studies have not generally found these subscales, apart from self-regulation (Velayutham and Aldridge 2012; Jain and Dowson 2009), to significantly impact on academic achievement.

The data in respect of the final two subscales, EGO and TSE exhibited non-normality. The data for EGO show that both students from Maths (M = 6.01, SD = 0.86) and from ML (M = 5.94, SD = 0.97) selected consistently high choices for these items, which may be counter-productive, as high levels of EGO and improving levels of self-regulated learning seem to be indirectly related (Slavich and Zimbardo 2012). The results for TSE for students from Maths (M = 4.88, SD = 0.91) and from ML (M = 4.78, SD = 0.86) did not reveal any interpretative opportunities.

These findings support those of Ketterlin-Geller, Chard and Fien (2008), namely that students lacking a firm foundation of pre-algebra concepts are disadvantaged when studying algebra. As found in other studies (Liu and Lin 2010; Payne and Israel 2010), it may be the lack of content knowledge that leads to lower levels of motivation in ML students when studying mathematics in this study too. An integrated solution process commencing with early identification, on-going interventions and continual monitoring that addresses both academic content and social-psychological attributes could be considered. Academic content can be developed through weekly sessions that aim to address the construction of foundation concepts that are lacking, yet required for understanding current content. Such an intervention may encourage ML students to further advance their current proficiency of learning strategies, which were found to be not significantly different from those of Math students in this study. Time on task in a non-threatening environment where cognitive strategies are supported through peer learning, where help is available, may boost students' effort regulation and positively impact motivation (Baumgartner 2016).

Additionally, Yaeger and Walton (2011) advocate the employment of social-psychological interventions to improve student achievement. Strategies of this type that have been shown to be successful are usually short and surreptitious in nature, complementing traditional opportunities to support recursive processes, and might include introducing transition interventions, implementing incremental theories of intelligence and employing strategies to reduce the threat of stereotyping weaker math students. Opportunities to allow students to describe their transition success or how they have improved over time, or why homework was relevant to their progress or creating their own list of value-affirmations are subtle methods shown by numerous studies listed in Yaeger and Walton (2011) to improve motivation and these have the propensity, alongside other reforms to generate long-lasting effects.

POTENTIAL IMPLICATIONS OF THE INQUIRY

The implications that this inquiry might have for HEs, but more importantly for academic development and the subject Mathematical Literacy are at least two-fold. On the one hand, there is the cost of developing and implementing an academic development intervention that addresses social-psychological attributes of ex-ML students alongside academic content. The question of who should have the primary responsibility for the design, implementation (facilitation) and monitoring of the intervention, as well as forthcoming research would also need to be considered. On the other hand are the benefits that might be reaped from such an endeavour. The opportunity to study and refine the reform process is of benefit to the HE, while there is the likelihood that a further benefit will be manifest in improved student results and throughput. The volume and success of previously documented social-psychological interventions suggest that the benefits of developing such a solution will outweigh the cost thereof.

Additionally, a topic for further study could be to investigate how one might address the similarities that were manifest in the learning strategy subscales. Such a study could potentially provide strategies to reduce the magnitude of the discrepancy between the variables found to exhibit significant differences in the motivation subscales and so positively impact academic development and achievement.

CONCLUSION

This article focused on comparing the motivation and learning strategies of students in a FP Mathematics course, who selected either Maths or ML in Grade 12. Fourteen of the 15 MSLQ subscales were shown to be reliable and nine of these displayed normality. Four of the six *motivation* subscales revealed significant differences between the two groups, while seven of the nine *strategies for learning* subscales were found to be not significantly different. The two groups of students in this study appear to display significant differences in their motivation as related to mathematics, while their strategies for learning mathematics appears to be relatively similar. This may be a profoundly important finding in light of the associations Zimmerman (1989) postulates between self-efficacy and strategy use to achieve SRL, motivation and achievement. As such, one option would be to view the applications of ex-ML students wishing to enter HE studies with caution. An alternative opportunity is to consider implementing strategies that aim to equip students (from either a Grade 12 Maths or ML background) entering an FP to pass a mathematics course.

Studies of first-year students (Diseth, Pallesen, Brunborg and Larson 2010) and

intervention strategies (Smith 2012) support more general findings that link motivation and learning strategies as aspects of SRL with academic achievement. As such, further studies at HEIs that offer equivalent programmes, to ex-ML students in particular, may build a knowledge bank on this topic so that appropriately informed strategies that equip ex-ML students mathematically may be developed. This, in turn, may improve the chance of these students succeeding in selected undergraduate degrees.

Additional studies may assist in moderating the limitations of this study. The limitation of collecting quantitative data from a single relatively small sample within a single institution at a single point in time should be noted as this may reduce the potential for generalizability or transferability. Additionally, the NSC has been replaced by the Curriculum Assessment Policy Statement (CAPS), further reducing the possibility of reproducing the study, although ML students continue to matriculate and seek HE study opportunities. Limitations relating to a self-reporting, Likert-scale instrument should also be noted, such as central tendency bias and social desirability bias (Bertram 2007), acquiescence bias (Johns 2010) and flaws when investigating the individual's perceptions along with lack of member checking (Harris and Brown 2010). The effects of these limitations were mitigated through careful planning to ensure that the study would withstand validity, reliability and trustworthiness tests. The above-mentioned limitations notwithstanding, a strategy aiming to improve their motivation is likely to be a noteworthy academic development initiative to ex-ML students.

This article proposes a strategy that simultaneously targets academic content alongside developing student motivation through social-psychological facilitations. Such a strategy should consider addressing elements that foster the development of motivation such as improving intrinsic goal orientation, task value and self-efficacy while simultaneously reducing test anxiety. Initiating such an intervention and gathering data on the results of this should then be studied further to determine its impact on the longer term academic success of ML students. More broadly, if such an academic development strategy is able to ultimately generate dividends, and a substantial number of ex-ML students manage to gain access to previously non-accessible undergraduate studies, this may unlock an unexplored and untapped student market to South Africa's HE sector.

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