LEARNING STRATEGIES, SELF-DIRECTED LEARNING AND PERFORMANCE OF PRE-SERVICE MATHEMATICS TEACHERS

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ABSTRACT—Advances in technology, learning environments, curricula, pedagogy and the conceptualization of how learners learn mathematics inevitably change the role of the teacher. Besides the inculcation of subject matter knowledge, the goal of the teaching-learning environment should be to help learners understand their own learning strengths and weaknesses. If pre-service teachers are to provide their future learners with the necessary learning strategies, they themselves as students must be consciously aware of their own learning strategies. Not only are learning strategies significantly related to academic performance, but the self-regulated use of learning strategies enable students to take more responsibility for their own learning and to become life-long learners. This paper reports on an investigation into the relationship between pre-service mathematics teachers’ use of learning strategies, and their self-directed learning, as well as their academic performance in a mathematics module. A quantitative non-experimental design was used to gather data by means of two questionnaires: the adapted LASSI and the Self-Rating Scale of Self-Directed Learning (SRSSDL), as well as students’ module mark. Spearman rank order coefficient was used to investigate relationships between sub-scales of the LASSI, the SRSSDL and students’ academic performance in a mathematics module. Results of the statistical analyses revealed correlations between subscales of the SRSSDL and students’ math performance, as well as between sub-scales of the LASSI questionnaire and student performance in the module.

Keywords: Pre-service mathematics teachers, learning strategies, self-directed learning, mathematics performance.

1. INTRODUCTION

Ever-changing teaching-learning environments, characterized by changes in technology, pedagogy and curricula, inevitably compel teacher educators to rethink the responsibilities of the teacher in the mathematics classroom. In addition to facilitating the acquisition of mathematics subject matter knowledge, the goal of the teaching-learning environment should be to help learners understand their own learning strengths and weaknesses. Teachers must, however, first have insight into and knowledge of how to provide students with the necessary learning strategies and how to access them. If pre-service teachers are to provide their future learners with the necessary learning strategies and how to access them, they themselves (as students) must be lifelong, self-directed learners who take responsibility of their own learning, are self-motivated and consciously aware of their own learning strategies.

A number of International and national studies (PISA 2003, 2012; SACMEQ, TIMSS and the National School Effectiveness Study [NSES], Taylor, 2011) has accentuated poor learner performance in mathematics. Although studies have revealed that inadequate teacher knowledge impacts negatively on learner performance (Hill, Rowan & Ball, 2005; National Education Evaluation & Development Unit [NEEDU], 2012), and the importance of mathematics content knowledge cannot be negated, there seems to be surprisingly little correlation between the number of mathematics courses taken by pre-service teachers and the performance of their learners (Davis & Renert, 2013). Mathematical subject knowledge is a necessary, but not sufficient prerequisite for learner success in the mathematics classroom (Van den Kieboom, Magiera & Moyer, 2013; NEEDU, 2012). Although teachers might be able to illustrate subject matter knowledge successfully by relying on rote procedures and algorithms that
they have learned, it is possible that they do not possess the full spectrum of mathematical knowledge for teaching. This mathematical knowledge for teaching also includes, among others, knowledge of the learning strategies employed by learners (Ball, Thames & Phelps, 2008) that might have enabled them to interpret and remediate their learners’ misunderstandings (Lloyd, 2014).

Although the Curriculum and Assessment Policy Statement (CAPS) (Department of Basic Education, 2011) aims to deliver learners that can organise and manage themselves and their activities responsibly and effectively, the explicit teaching of self-directed learning strategies does not realise in the mathematics classroom. International studies (PISA 2012) suggested that the teaching of procedures and formulas do not necessarily teach learners how to think and reason mathematically. Learners need to be taught how to question, see relationships, to make predictions and generalisations (OECD, 2016). To help learners learn the more complex and analytical skills they need for the 21st century, teachers must learn to teach in ways that develop higher-order thinking and performance (Darling-Hammond & Richardson, 2009). Teachers who encourage learners to explain their mathematical thinking processes, to think metacognitively, and to monitor and regulate their thinking processes and learning strategies, create a more productive learning environment (Bolhuis & Voeten, 2001). If mathematics teachers were able to successfully model these self-directed learning skills in the classroom and actively involve mathematics learners in their own learning processes, it may change learners’ learning in mathematics.

Teachers are no longer capable of, or expected to supply learners with all the information they will need in their future lives. Opportunities should be created where learners are enabled to develop the ability and means to search for, absorb and integrate new information with prior knowledge. Learners must therefore be encouraged to develop a positive disposition toward continuous engagement in lifelong learning (Mok & Lung, 2005) as well as to improve their understanding of their own learning (Boström & Lassen, 2006). The purpose of this article is to report on the results of a study to ascertain if there is a relationship between pre-service teachers’ learning strategies, their capabilities in terms of self-directed learning, and their academic performance in a mathematics module on geometry.

2. CONCEPTUAL-THEORETICAL FRAMEWORK

2.1 Self-directed learning in mathematics education

Ley (2005) describes self-directed learners as learners who can self-regulate as well as self-motivate. Bolhuis (2003) and De Bruin (2007) define self-directed learners as learners who take responsibility and ownership for their own learning. Kramarski et al. (2013, p. 1) assert that learners are self-regulated to the extent that they are “cognitively and metacognitively motivated and behaviorally active participants in their own learning process”. In an ever-changing teaching-learning environment, self-directed learning is not only an ultimate goal of the teaching and learning of mathematics, but also an important characteristic of effective teaching and learning (De Corte et al., 2011).

Self-regulated learners are able to actively support their own learning cognitively, metacognitively and motivationally by planning, organising, monitoring and evaluating their learning strategies. Self-regulated learners are inclined to be goal-directed, manage their time, use cognitive and metacognitive strategies appropriately. Francom (2010) suggests that learners are enabled to develop self-directed learning skills when students are afforded the opportunity to integrate the management of time and resources with monitoring, evaluation and regulation of their cognitive strategies. In order for students to become self-directed learners, they must learn to assess the demands of the task; evaluate their own knowledge and skills; plan their approaches; monitor their progress; and apply, monitor and adjust their learning strategies and approaches to learning as needed (Ley & Young, 2001; Ambrose et al., 2010; Sindhwani & Sharma, 2013).

2.2. Learning strategies

The word “strategy” is derived from the ancient Greek word “strategia” meaning “general” in the military sense. Although the military meaning has evolved, the word still describes a plan of action
designed to achieve a long-term or overall aim (Lin & Tai, 2015). Learning strategies are conceptualised as all kinds of planned and conscious learning behaviour and attitudes behind it, including actions (solving problems, asking questions) as well as thought processes (planning, monitoring and reflection) (Griese et al., 2015). Learning strategies portray the way students select, acquire, organise and integrate new knowledge (Weinstein & Mayer, 1986). From a constructivist perspective, the absence of appropriate learning strategies may result in students not being able to benefit from the opportunity to construct powerful mathematical ideas and to become mathematical persons (mathematical thinkers and learners) (Anthony, 1996). There seems to be a cyclic relationship between the use of appropriate learning strategies and academic performance. Causality between adequate learning strategies and successful learning is also well established (Diseth, 2011; Schutz, 2011; Keklik & Keklik, 2013). Students with outstanding mathematics performance adopt learning strategies appropriate to manage their learning. By contrast, students with relatively poor mathematics performance cannot apply effective learning strategies to solve problem or monitor their learning. Teachers can facilitate students’ mathematical learning by providing direct and explicit instructions about strategies for understanding mathematics and solving problems (Anthony, 1996; Thiessen & Blasius, 2008).

Research reveals that students’ cognitive reflection, as a metacognitive variable, their beliefs about mathematics, and their self-efficacy, are all correlated positively and significantly with mathematics achievement (Gomez-Chacon et al., 2014). There is also evidence that metacognition impacts positively on learning strategies which in turn influences achievement (Griese et al., 2011). Studies have also revealed that motivation and the applicable use of learning strategies is a better predictor of math achievement than intelligence (Murayama et al., 2013). In this regard metacognition plays a pivotal role. Anthony (1996) asserts that a significant aspect of successful learning is the ability of knowing when to use a learning strategy (conditional knowledge) as well as knowledge of how to use it. For students to take a more active role in monitoring and controlling their learning they need to build appropriate metacognitive knowledge based on learning experiences which allow them to evaluate and adapt their learning strategies in a variety of learning contexts (Shetty, 2014). Students used to metacognitive thinking, assume greater responsibility for their own learning. They are aware of their own strategies and are open to modifications of their thought processes.

There appears to be a triangular relationship between academic performance, learning strategies and self-directed learning. The relationship between students’ self-regulated use of learning strategies and academic performance is well established (Diseth, 2011; De Guzman et al., 1998; Keklik & Keklik, 2013). The self-regulated uses of learning strategies also enable students to take responsibility for their own learning and to become life-long learners (Shetty, 2014; Weinstein, Acee & Jung, 2011). The purpose of this study is to establish the relationship, if any, between aspects of pre-service mathematics teachers’ (as students) learning strategies, self-directed learning and performance in a mathematics module.

3. METHODOLOGY

3.1. Research design
This research made use of a quantitative method approach. A non-experimental survey design was used (Maree & Pietersen, 2016). This is a correlational study that involved pre-service mathematics teachers in their third year of study. The students completed two questionnaires (see par 3.3). The scores of the subscales of learning and study strategy questionnaire (LASSI), dimensions of self-directed learning (SRSSDL), as well as students’ module mark at the end of the semester were investigated.

3.2. Sampling
A purposeful sample of 44 intermediate phase mathematics students (as pre-service teachers) was used in this study. The researcher is the lecturer for this group of students, and wanted to explore the possible relationship between their self-directedness, their learning strategies as well as their academic performance. These students were in their third study year in the Bachelor of Education (BEd) program in the Faculty of Education Sciences at a South African University at the time of the investigation. The
sample consisted of 37 female and 7 male students. The language of instruction was Afrikaans, but interpreting services was available for two English speaking students. The students’ module mark is represented in Figure 1. Eight students failed the module (<50%), while ten students obtained a distinction (≥ 75%) in the module.

![Module mark distribution](image)

**Figure 1: Students’ module mark**

### 3.3 Measuring Instruments

Two questionnaires were administered, namely an adapted Learning and Study Strategies Inventory (LASSI) (Weinstein & Palmer, 2002; Nieuwoudt, 2003), as well as the Self-rating Scale of Self-Directed Learning (SRSSDL) (Williamson, 2007). The LASSI consists of 76 questions, based on a five-point Likert scale, divided into ten subscales. These ten subscales include attitude, anxiety, motivation, concentration, time management, information processing, selecting main ideas, self-testing and test strategies. The number of items within each subscale is indicated in Table 1 and 2 respectively.

The SRSSDL consisted of 60 questions, also presented on a five point Likert scale. SRSSDL is a valid and reliable instrument in assessing learners’ levels of self-direction in learning and can be used to facilitate the teaching-learning process to enhance self-directed learning skills (Williamson, 2007). The five dimensions of self-directed learning covered in the questionnaire are: awareness, learning strategies, learning activities, evaluation and interpersonal communication skills.

The students’ module marks at the end of the semester were also used to investigate correlations with these two questionnaires. LASSI was completed by 40 students, and only 28 students completed the SRSSDL.

### 3.4 Ethical aspects

Ethical clearance was obtained from the Ethics committee of the Faculty. Students also gave their informed consent. Students were assured that their module mark would in no way be influenced by their responses. Confidentiality and anonymity of students were guaranteed.

### 3.5 Data collection

The LASSI questionnaire was administered at the end of the semester at the end of a contact session. Due to time constraints, students were asked to complete the SRSSDL questionnaire online after the class. This may be one reason for a low response rate (only 28 students managed to complete the SRSSDL online). The module mark was composed of various in-class assignments, individual assignments, five progression tests (of which the lowest mark was omitted), as well as the examination mark.

### 3.6 Reliability and Validity of the Instruments
Williamson (2007) reported acceptable and satisfactory internal consistency (Cronbach α-values between 0.71 and 0.79) for the items in the original SRSSDL questionnaire. In this study, the Cronbach α coefficients varied between 0.65 and 0.76. Weinstein and Palmer (2002) reported Cronbach α values ranging between 0.68 and 0.82 for the different sub-scales of the LASSI, while Nieuwoudt (2003) reported Cronbach α values between 0.60-0.83 for the adapted LASSI. In this study the Cronbach α coefficient ranged from 0.65-0.89, which is regarded as acceptable to good (Gliem & Gliem, 2003). The SRSSDL questionnaire was developed by using the modified Delphi technique and is reported to be a valid instrument in identifying students’ self-directed learning (Williamson, 2007). The items in the LASSI instrument measures students’ learning strategies and has also found to have content and construct validity (Pottier, 2015).

3.7 Data processing and analysis
Statistical data analysis was done by the Statistical Consultation Services. The Spearman rank order correlation coefficient (Spearman’s rho) was used to indicate whether statistical relationships existed between subscales of students’ learning strategies, self-directed learning and their module mark respectively.

4. RESULTS
4.1 Results of the descriptive statistics
Descriptive statistics of the LASSI and SRSSDL questionnaire will now be presented in Table 1 and Table 2.

<table>
<thead>
<tr>
<th>Subscales of LASSI</th>
<th>Number of items</th>
<th>Mean out of 5</th>
<th>Standard deviation</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude (att)</td>
<td>8</td>
<td>4.22</td>
<td>.623</td>
<td>40</td>
</tr>
<tr>
<td>Motivation (mot)</td>
<td>8</td>
<td>3.8</td>
<td>.603</td>
<td>40</td>
</tr>
<tr>
<td>Time management (tmt)</td>
<td>7</td>
<td>3.34</td>
<td>.726</td>
<td>40</td>
</tr>
<tr>
<td>Anxiety (anx)</td>
<td>8</td>
<td>2.94</td>
<td>.709</td>
<td>40</td>
</tr>
<tr>
<td>Concentration (con)</td>
<td>8</td>
<td>3.8</td>
<td>.745</td>
<td>40</td>
</tr>
<tr>
<td>Information processing (inp)</td>
<td>8</td>
<td>3.3</td>
<td>.515</td>
<td>40</td>
</tr>
<tr>
<td>Selecting main ideas (smi)</td>
<td>5</td>
<td>3.57</td>
<td>.783</td>
<td>40</td>
</tr>
<tr>
<td>Study aids (sta)</td>
<td>8</td>
<td>3.63</td>
<td>.631</td>
<td>40</td>
</tr>
<tr>
<td>Self-testing (sft)</td>
<td>8</td>
<td>3.53</td>
<td>.562</td>
<td>40</td>
</tr>
<tr>
<td>Test strategies (tst)</td>
<td>8</td>
<td>3.45</td>
<td>.786</td>
<td>40</td>
</tr>
</tbody>
</table>

It seems from Table 1 that participants score above average in each of the subscales of the LASSI. It should be noted that the anxiety subscale is scored reversely, in other words higher score in this subscale is an indication of lower levels of anxiety (Pottier, 2015). The attitude subscale scored the highest average (4.2 out of 5) which may be an indication that the group of participants has a positive attitude towards learning and achieving in mathematics. Motivation scored the second highest average, which may be explained by the fact that it links closely with attitude. Thus, together with a positive attitude, these students seem to be motivated to exert effort in the learning of mathematics.

<table>
<thead>
<tr>
<th>Subscales</th>
<th>Number of items</th>
<th>Mean (out of 5)</th>
<th>Standard deviation</th>
<th>Total number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness</td>
<td>12</td>
<td>4.08</td>
<td>.36</td>
<td>28</td>
</tr>
</tbody>
</table>
From Table 2 it seems as if the students viewed themselves as self-directed learners according to the mean scores in the different subscales of the SRSSDL questionnaire, with mean scores ranging from 3.71-4.10 out of 5. Hence the Spearman rank order correlation coefficient (Spearman’s rho) between the students’ module mark (MM) and the subscales of the LASSI and SRSSDL questionnaires are presented in table form respectively (Table 3 and Table 4).

4.2 Results of the inferential statistics
Table 3: Spearman rank order coefficient (Spearman’s rho) between module mark and sub-scales of the adapted LASSI

<table>
<thead>
<tr>
<th></th>
<th>MM</th>
<th>att</th>
<th>mot</th>
<th>tmt</th>
<th>anx</th>
<th>con</th>
<th>inp</th>
<th>smi</th>
<th>Sta</th>
<th>sft</th>
<th>tst</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>att</td>
<td>.396</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mot</td>
<td>.571</td>
<td>.492</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tmt</td>
<td>.419</td>
<td>.698</td>
<td>.732</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>anx</td>
<td>.216</td>
<td>.617</td>
<td>.427</td>
<td>.452</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>con</td>
<td>.449</td>
<td>.636</td>
<td>.679</td>
<td>.707</td>
<td>.660</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inp</td>
<td>.413</td>
<td>.463</td>
<td>.456</td>
<td>.587</td>
<td>.411</td>
<td>.367</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>smi</td>
<td>.198</td>
<td>.565</td>
<td>.547</td>
<td>.553</td>
<td>.810</td>
<td>.659</td>
<td>.337</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sta</td>
<td>.230</td>
<td>.329</td>
<td>.618</td>
<td>.475</td>
<td>.137</td>
<td>.357</td>
<td>.383</td>
<td>.284</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sft</td>
<td>.400</td>
<td>.493</td>
<td>.738</td>
<td>.630</td>
<td>.299</td>
<td>.412</td>
<td>.536</td>
<td>.377</td>
<td>.691</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>tst</td>
<td>.397</td>
<td>.627</td>
<td>.529</td>
<td>.626</td>
<td>.805</td>
<td>.766</td>
<td>.410</td>
<td>.822</td>
<td>.169</td>
<td>.307</td>
<td>1</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level; *correlation is significant at the 0.05 level

Strong positive correlations (0.4<r<0.75) exist between the students’ module mark and the sub-scales motivation, time management, concentration, information processing. Moderate correlations (0.3<r<0.4; significant at the 0.05 level) were found between attitude, self-testing and test-strategies. There were no significant correlations between the module mark and anxiety, selecting main ideas and study aids. Strong, positive correlations (0.4<r<0.75) were found between most of the sub-scales of the LASSI (see Table 3). Very strong positive correlations (r>0.75) were found between test-strategies and anxiety, as well as test-strategies and selecting main ideas. These correlations indicate a strong relationship between the respective sub-scales of the LASSI, which means that high (low) values in one sub-scale relates to high (low) values in anther sub-scale.

Table 4 Spearman rank order coefficient (Spearman’s rho) between module mark and sub-scales of the SRSSDL

<table>
<thead>
<tr>
<th>Subscales</th>
<th>MM</th>
<th>AW</th>
<th>LS</th>
<th>LA</th>
<th>EV</th>
<th>IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness (AW)</td>
<td>.37</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning strategies (LS)</td>
<td>-.41</td>
<td>.161</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning activities (LA)</td>
<td>.097</td>
<td>.353</td>
<td>.673</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluation (EV)</td>
<td>-.009</td>
<td>.433</td>
<td>.582</td>
<td>.759</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Interpersonal skills (IP)</td>
<td>-.234</td>
<td>.208</td>
<td>.577</td>
<td>.599</td>
<td>.503</td>
<td>1</td>
</tr>
</tbody>
</table>

MM = Module mark; **correlation is significant at the 0.01 level; *correlation is significant at the 0.05 level

From Table 4 there appears to be no significant correlation between the students’ module mark and any of the sub-scales of the SRSSDL. There are however strong, positive correlations (r>0.5; significant at the 0.01 level) between learning strategies and learning activities, evaluation and interpersonal skills; learning activities with evaluation and interpersonal skills; and evaluation with interpersonal skills. There also appears to be a moderate correlation (r > 0.4; significant at the 0.05 level) between evaluation and awareness. Possible relationships between the sub-scales and dimensions of the two questionnaires (LASSI and SRSSDL) are now investigated.
There appears to be no significant correlation between any of the sub-scales of the Learning and Study Strategy Inventory (LASSI) and the Self Rating Scale for Self-Directed Learning except for moderate to strong correlations ($r=0.49$ and $r=0.508$ respectively; significant at the 0.01 level/ N=24) between attitudes and learning strategies, and awareness and selecting main ideas (Table 5). Unfortunately, although 40 students completed the LASSI questionnaire, only 24 of these students also complete the SRSSDL questionnaire.

5. DISCUSSION AND CONCLUSION
The purpose of this article was to report on results of a study investigating a relationship between academic performance in a mathematics module, learning strategies and self-directed learning. Apart from the descriptive statistics, correlations between sub-scale of the LASSI and SRSSDL questionnaires were investigated. From the Cronbach $\alpha$ coefficients, it appeared that the internal consistency within each of the questionnaires were acceptable to good. The descriptive statistics for both questionnaires indicated that the students demonstrated appropriate learning strategies, and they perceive themselves as self-directed learners (as measured by the means and standard deviation in the respective questionnaires). There appeared to be strong positive correlations between most of the sub-scales and dimensions of the LASSI questionnaire. The results also yielded moderate to strong correlations between seven of the ten fields of the LASSI questionnaire, and students’ module mark. A number of studies involving the LASSI explored the relationship between elements of strategic learning and academic performance in general (Albaili, 1997; Cano, 2006; Pottier, 2015; Schutz et al., 2011). Although results of these studies do not necessarily agree in terms of which subscale correlates better with academic performance, a few studies have reported the motivation subscale of the LASSI as a key predictor of academic performance (Albaili, 1997; Schutz et al., 2011). Pottier (2015), however, did not find any significant relationship between motivation, information processing, test-strategies and academic performance in mathematics specifically (although in other subjects).

The findings from this study partly concur with Seabi’s (2011) findings, who concluded that three subscales of the LASSI, namely, Attitude, freedom from Anxiety and Test Strategies significantly predicted academic achievement. This study, however, did not reveal statistical significance between anxiety and performance in mathematics. The results do however suggest that for students to be academically successful, they need to have a positive attitude towards the learning of mathematics, be motivated, learn to manage their time in preparing for contact session and examinations, acquire strategies to construct meaning in learning new concepts (information processing). To perform
academically, students have to acquire strategies to evaluate themselves, (self-testing), as well as for examination preparation, planning, including examination question and error analysis (test-strategies). As can be expected, the results from this study revealed strong positive correlations between the subscales and dimensions of the SRSSDL questionnaire, Contrary to other studies (Schneider & Artelt, 2010; Vrugt & Oort, 2008; Young & Fry, 2012), which reported relationships between aspects of self-directed learning and mathematics performance, there were no significant correlations between the subscales of the SRSSDL and the performance in a mathematics module. These findings also coincide with results from a study by Van der Walt (2014). In contrast to these findings, other studies suggested relationships between aspects of self-directed learning and performance in mathematics.

6. LIMITATIONS OF THIS STUDY
In addition to the fact that the sample in this study was small (N = 40), only 24 students completed both questionnaires. Correlations had to be calculated for this small group. It is therefore suggests that this study be repeated in future with a larger cohort of students. Another limitation of this study, is the fact that both the LASSI, as well as the SRSSDL is based on self-evaluations (Schutz et al., 2011), which may not be a true reflection of reality. The students’ self-evaluations may not always correspond with their actual behaviours. It seems as if students are inclined to over-estimate their self-directed learning skills. Students may not always be aware of their own learning processes, which are also suggested by Okoro and Chukwudi (2011). Consequently, students fail to analyse the effectiveness of their learning strategies and adapting or changing their strategies when necessary. It should be emphasised however that more data is needed over a longer period of time to ascertain relationships between students’ self-directed learning, learning strategies and mathematics performance strategies.

REFERENCES


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