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The purpose of the present study was to evaluate whether there is evidence of reflection in student-written journals and to investigate whether students show improvements in their reflective skills through journal keeping. To that end, the reflection journals of 3460 first-year students enrolled in a polytechnic were studied by means of an automated coding procedure. Data used in the analyses were students' journals for an entire week, collected once at the beginning and again at the end of an academic year. Outcomes of the content analyses suggest that there is evidence of reflection in students' journals and that students reflected on three general categories related to their learning: critical review of past learning experiences, cognitive learning strategies and summaries of what was learnt. Furthermore, the findings also indicate that students show improvements in their reflective skills as they progressed through the academic year. The findings when taken together suggest that reflection journals can be used to promote self-reflection and learning amongst students.

Keywords: learning; metacognition; reflection journals; self-reflection; text analysis

Introduction

The incorporation of reflection journals as learning and assessment tools into programmes of study within higher education arises from the recognition of the possible positive roles that reflection may play in fostering students' self-reflection, critical thinking and creative writing abilities and in the demonstrable development of professional values or skills (Hubbs & Brand, 2005; Morrison, 1996). More recently, there has been a growing interest in reflection journals to be used as part of a reflexive metacognitive strategy. Reflection journal writing is believed to enable students to critically review *processes* of their own learning and behaviours and to understand their ability to transform their own learning strategies (Gleaves, Walker, & Grey, 2008). The purpose of the present study was to evaluate whether there is evidence of reflection in student-written journals and to investigate whether students show improvements in their reflective skills through journal keeping. Furthermore, the study also attempts to code students' journal responses in an objective manner by subjecting their reflection journals to text analysis using an automated coded procedure.

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Reflection journals as tools for learning

Reflection journals are variously referred to as 'reflective journals' (e.g. Chirema, 2007), 'reflective learning journals' (e.g. Thorpe, 2004) or 'learning journals' (e.g. Langer, 2002). Although used in a variety of courses, reflection journals are essentially written records that students create as they think about various concepts learnt, about critical incidents involving their learning or about interactions between students and teachers over a period of time for the purpose of gaining insights into their own learning (Thorpe, 2004). Several authors (e.g. Dart, Boulton-Lewis, Brlwolee, & McCrindle, 1998; Haigh, 2001) have emphasized that reflection journals, by focusing on the *processes* (e.g. self-reflection and learning strategies) rather than the products (e.g. summaries of knowledge acquired) of learning, may enable students to improve on their reflective capacity and skills.

Why is reflection deemed important? There is a widely-documented view that self-reflection enhances professional practice, since the learner is involved in processes that explore experience as a means of deepening understanding (Boud, Keogh, & Walker, 1985). These processes include 'looking back on experiences, decisions and actions; recognizing values and beliefs underlying these actions and decisions; considering the consequences and implications of beliefs and actions; exploring possible alternatives; and reconsidering former views' (Sumsion & Fleet, 1996, p. 121). Sumsion and Fleet further contend that since processes such as these can lead to informed and thoughtful deliberation on one's beliefs and actions, they are expected to assist learners in becoming reflective practitioners.

The use of reflection journals as a learning tool therefore highlights the role of self-reflection in learning. Self-reflection (or simply reflection) has received numerous definitions from different sources in the literature. Depending on the emphasis on theory or practice, literature definitions vary from philosophical articulations as in Dewey (1991), formulations in theoretical frameworks, such as the 'reflection-in action' and 'reflection-on-action' constructs developed by Schön (1983), to the use of reflection in the experiential learning cycle by Kolb (1984). What further complicates the picture of self-reflection is the range of different purposes or outcomes that the activity of reflecting seems to fulfil. Besides seeking to develop metacognition in students, other purposes of journal keeping include: to critically review the behaviours (e.g. strengths and weaknesses, learning styles and strategies) and learning of self and others, or the products of learning, to set or track learning goals and to explore connections between knowledge that was learnt and students' own ideas about that knowledge (Moon, 1999).

Effects of reflection journal writing on student learning

The different purposes and outcomes of self-reflection closely match many of the purposes for reflection journal keeping. The provision of reflective activities like journal writing provides opportunities for the learner to reflect and write about new information or ideas, thus better understanding and remembering them. The articulation of connections between new information, ideas, prior or existing knowledge also deepens learning. This in turn enhances the learner's cognition and metacognition (O'Rourke, 1998).

A particular emphasis on cognition and metacognition is evident in the research on factors influencing effective classroom learning (Marton & Säljö, 1984). Weinstein and Mayer (1986) identified three groups of cognitive learning strategies that enhance a

learner's cognition and the acquisition and retention of information: *rehearsal*, *organization* and *elaboration*. *Rehearsal* involves the learner in repetition of to-be-learnt information in a form relatively unchanged from the form in which it was given. Oral repetition, copying and making selective verbatim notes are some examples of rehearsal strategies. *Organization* involves the learner in rearrangement of to-be-learnt information in a way that makes content more meaningful. Examples of organizational strategies include categorizing and constructing networks. *Elaboration* involves the learner in integration of presented information with prior knowledge. Examples of elaboration strategies include paraphrasing and summarizing.

Journal keeping has been positively associated with enhancing student metacognition. In his work, Vockell (2004) describes metacognitive skills (organizing, planning, monitoring and evaluation) as the learners' automatic awareness of their own knowledge and their ability to understand, control and manipulate their own cognitive processes (see also Flavell, 1979). In reviewing the literature on teaching and learning in the past century, the American Psychological Association (1997) highlighted metacognition as one of the more important factors in contributing towards effective learning. The review suggests that as students' metacognitive abilities develop, so does their ability for self-reflection and self-regulation of learning, thus leading to improvements in academic performance. This is illustrated in the work by McCrindle and Christensen (1995), whose study explores the impact of journal writing on cognitive and metacognitive processes and academic performances of 40 undergraduates in a first-year biology course. Students were randomly assigned to a learning journal (experimental) group or scientific report (control) group. Their findings demonstrate that students in the experimental group used more cognitive and metacognitive strategies during a learning task, showed more sophisticated conceptions of learning, greater awareness of cognitive strategies and demonstrated the construction of more complex and related knowledge structures when learning from text. Furthermore, they also performed significantly better on the final examination for the course.

The literature offers evidence that students, regardless of their domains of study, show improvements in their learning, viz., students becoming better in self-assessment, through journal keeping. For instance, Selfe, Petersen and Nahrgang (1986) investigated the use of journals in a college-level mathematics course where students were asked to describe in their own language, mathematical concepts. Their study showed that while reflection journals did not necessarily assist students with earning high grades on achievement tests, journals did assist students in developing abstract thinking, thereby enabling them to better conceptualize the meaning of technical definitions. Furthermore, students appeared to develop better strategies in problem solving through writing as compared to mere memorizing of calculations. The findings by Selfe and others were mirrored in the work by Moon (1999), in which she summarized a number of studies that examined the effects of journal writing on student academic achievement across a variety of disciplines. In all, her work demonstrated the influence of journal keeping on student academic performance was subtle and did not seem to assist students with achieving better achievement test grades. Instead, journal keeping seems to facilitate student learning in a number of ways, among them: synthesizing new knowledge about a domain subject with their prior knowledge and learning and recording of useful strategies in solving problems.

By contrast, other researchers are less positive about the effects of journal writing on student learning. For instance, Woodward (1998) describes a study in which all students in an undergraduate teaching course had to keep journals in all their subjects.

Although questions were not used as prompts for journal writing, students were told that they must reflect on descriptions, observations or notes related to their learning and record the proposed actions taken to further improve in their journals. Close examination of students' journal responses revealed that they were far from reflective and were merely diary entries describing an event or activity. The findings by Woodward are mirrored in the study by Bain, Ballantyne, Packer and Mills (1999), who examined the effectiveness of using journal keeping as a means to enhance the reflectivity of 35 student teachers during field experience placements. Students were randomly assigned to four intervention conditions, which varied the content of journaling (experiential or cognitive) and the context (provision of reflective dialogue based on journal entries or self-analysis) and instructed on what to reflect on in their reflection journals. Based on the 366 journals collected, Bain and others reported that they were mainly descriptive: what had happened and what may be done differently were documented, but deeper questions of how and why were left unasked. Others problems reported in the use of journal writing are the use of reflection journals as instruments for attacking fellow students or writing only what the teachers would like to read (Lew & Schmidt, 2006).

Determining the level of reflection in student learning

Besides the potential effects of journal writing on student learning suggested by the papers reviewed above, there is a body of literature reporting empirical studies on the assessment of reflection in learning. These studies consider the question of assessing the level of reflective thinking from students' journals by means of coding schemes. For instance, Kember and co-workers (1999, 2000, 2008) developed a body of research estimating the level of reflective thinking in students' journals. In their most recent work, they developed a four-category scheme – habitual action/ non-reflection, understanding, reflection and critical reflection – to guide the coding and allocation of written work. High inter-rater agreement was obtained when the coding scheme was tested on four clinical placement reports. Nonetheless, there was the issue of generalizability of their findings, given the small sample sizes involved in their studies. Wong, Kember, Chung and Yan (1995) reported the use of a framework to allocate adult nursing students to three categories of non-reflector, reflector and critical reflector, based on their journal responses. The authors described the coding scheme as a mirror of the conceptual frameworks developed by Boud et al. (1985) and Mezirow and colleagues (1991). Though the method was well documented, the authors cautioned that identifying textual elements within student journals and allocating them to finer levels of reflection within Boud's model was a difficult process and felt that the levels of reliability they could achieve were not suitable for recommending for further use by others. Steward and Richardson (2000) also shared concerns over the inauthenticity of assessing reflection journals.

The reliability and validity of studies such as those reviewed here were being questioned since most involved only a limited number of participants who engaged in journal writing only on a few occasions throughout a course. In order to ensure that coding of student reflection journals is done in a standardized manner, a detailed set of coding instructions must first be created to guide the work. This makes the task time-consuming and expensive. Even then there may be disagreements among coders on how to categorize specific responses, reducing the reliability of the resulting data. Furthermore, the coding procedures described lacked details on how they were carried out or were too complicated for use in analyzing large numbers of journal entries.

Aims of this study

The present study seeks to determine whether there is evidence of reflective activities in students' journal responses. We were interested to find out whether students' journals, in agreement with what the literature suggests, focus on critical reviews of their own and/or that of their peers' processes of learning and behaviours and understanding of learning strategies used to enhance their metacognition. Furthermore, we were also interested to find out to what extent students use reflection journals to summarize the content of what they have learnt. This is considered to be descriptive (rather than reflective) and regarded by some as ineffective in enhancing students' reflective abilities, as it is thought to hinder the objective of developing critical thinking and metacognitive skills (Voss, 1988). But to what extent does reflection actually emerge in these responses?

A second goal of the study was to investigate whether students show *improvements* in their reflective skills through journal keeping. It was hypothesized that students' awareness of how they learn would improve as they progress through the course, engaging in continuous journal keeping. For instance, Dart et al. (1998) found that students' insights became more profound as their journals progressed and that the nature and quality of thinking and reflection, as well as their influence on practice, also developed.

A third and final goal of the present study was subjecting student reflection journals to text analyses by means of an automated coding procedure. This means that the coding process is in principle performed in a consistent, objective and reliable manner and can be performed in a fraction of the time required to do so manually. Another potential advantage of a coding scheme as developed in this study is that it can be easily applied to analyse large data sets of student journals. In order to maximize the validity of our findings, we did not rely on single journal entries of a selected, small group of students. Instead, the journals by all participants (more than 3000 first-year students of a polytechnic) were involved in the study presented here, with each of them writing approximately 150 journal entries in an academic year.

Methods

Subjects

Participants were 3460 students in their first year of studies at a polytechnic in Singapore in the academic year 2007–2008. Of these students, 1765 (51%) were female and 1695 (49%) were male, their mean age was 18.64 years ($SD = 1.46$).

Educational context

Problem-based learning

The polytechnic at which the research was carried out organizes its curriculum according to principles of problem-based learning (Schmidt & Moust, 2000). Students work collaboratively in teams of four to five, with learning centred on problems relevant to their domain of study. They work each day on one problem. The problem is initially discussed in the morning, followed by ample study. At the end of the day, information gathered is shared and elaborated upon. No didactic teaching takes place nor is there any form of direct instruction. One tutor supervises the student teams in a larger classroom. His or her role is to facilitate student learning (Alwis, 2007). There are two semesters in an academic year, with each semester lasting 16 weeks. All the

courses offered are three-year curricula. Regardless of their disciplines, all students take common modules in their first-year of studies. These modules include Sciences, Mathematics, Programming, Communication and Problem-solving.

Assessment in the curriculum

The daily assessment approach involves students having to assess their own process of learning (i.e. self-assessment) and that of their peers (i.e. peer assessment), writing a reflection journal and a judgment by the tutor on how well students have performed during the day.

The reflection journal is a short essay created by the student that is 'personal' and records his or her daily reflections of daily learning in response to a reflection journal question provided by the tutor. Each student is required to respond to one journal question per day. The student then submits his or her reflection journal electronically by means of an online platform by the end of the day. Tutor-asked journal questions mainly required students to be reflective about their learning and development. Some examples of reflection journal questions include: 'What are some of the strengths that I demonstrated today?', 'What insights did I gain today?', 'What strategies have I used to help me in my learning', 'What prior knowledge did I apply to help me understand the problem better?' and so on. Students respond to a different reflection journal question each day during a five-day workweek. The didactic purpose of writing the reflection journal is in line with the literature reviewed above, to encourage and record self-reflection about the process of learning.

In addition, students also need to take four knowledge acquisition tests per module, which are taken at different points during the semester. The duration of each test is 30 minutes and it consists of answering at least three open-structured questions. The tests are conducted in a supervised environment, similar to an end-of-course examination. Students are tested on their ability to understand and apply what they have learnt.

Instruments

In seeking evidence of reflective activities through reflection journal writing, student journals were analyzed using the SPSS Text Analysis for Survey™ software (SPSS, 2006). The software uses advanced linguistic theory technologies that extract and classify key concepts from student journal responses. These technologies analyze content as a set of phrases and sentences whose grammatical structure provides a context for the meaning of a response. The software enables the coding and categorization of journal responses in a fraction of the time required to do the job manually. Another benefit is that the categorization of responses is done consistently and reliably – the responses are analyzed in an iterative manner. Unlike human coders, the software classifies the same response in the same categories every time.

The first step in content analysis is to extract keywords, compound words and patterns in the journal responses. The libraries supplied with the software contain pre-coded definitions and these were the linguistic resources used to identify relevant concepts. These extracted terms were grouped into categories (i.e. closely related concepts, opinions or attitudes) by the software. The software relies upon three linguistic-based techniques that take into account the root meanings of the extracted terms and their relationship between sets of similar objects or opinions: *term derivation*, *term*

inclusion and *semantic networks* (SPSS, 2006, p. 101). Because these techniques are complementary, all of them are used for categorizing the extracted terms.

The *term derivation* technique creates categories by taking a term and finding other terms that are related to it by analyzing whether any of the terms components are morphologically related. For instance, 'opportunities for self-reflection' would be grouped with the term 'self-reflection opportunities'. The *term inclusion* technique uses algorithms to create categories by taking a term and finding other terms that include it – word order and the presence of such words as 'in' or 'of' are ignored. As illustration, given the term 'skill', term inclusion will group terms such as 'programming skills' and 'a set of skills' in a skill category. The root term used to create the category (skill) can have words before it, after it or both before and after ('programming skill set').

The *semantic networks* technique creates categories using a semantic/lexical network based on WordNet®, a linguistic project based at Princeton University (Miller, 2006). WordNet® is a reference system of 'Nouns, verbs, adjectives and adverbs grouped into sets of cognitive synonyms, each representing one underlying lexical concept' (p. 101). This method begins by identifying extracted terms that are known synonyms and hyponyms (i.e. a word that is more specific than the category represented by a term, e.g. student, tutor and peer are hyponyms of the term 'person').

In order to analyze the journal responses in a more meaningful fashion, a custom library was created. This library contained domain-specific words and terms (with synonyms) that arose from the modules taken by all first-year students. These modules consisted of several tasks which asked students to create spreadsheets and basic computer programs to perform simple numerical functions. Using these modules as an example, domain-specific words would include 'visual basics programming', 'Microsoft excel graphs', 'spreadsheets' etc.

The categories that were automatically generated were also renamed to capture their essential meanings. The descriptions of the categories obtained are contained in Table 1. It took around 3 months to set up the coding system (including data collection).

Procedure

Data used in the analyses were student reflection journals for the entire week, collected once at the beginning of (i.e. week-3 of the first semester) and again at the end (i.e. week-14 of the second semester) of the academic year 2007–2008. Identical categories were generated for both sets of data. The number of instances when each category appeared in each journal response was recorded and used for subsequent statistical analyses.

Analysis

Descriptive statistics (means and standard deviations) of the frequency counts for the categories were computed. Paired-sample *t*-tests were also performed to examine if the differences in the mean frequency count of the categories generated based on student reflection journals written at the beginning and the end of the academic year were statistically significant.

To further examine the magnitude of the difference in the mean categorical values for that of week-3 as compared to that in week-14, effect size (Cohen's *d*) values were computed. A rule of thumb for describing the magnitude of effect sizes can be attributed to Cohen (1969). According to Cohen, an effect size of .20 should be regarded as

Table 1.   Description of categories generated by means of text analysis software.

Category	Sub-category	Description	Examples of reference studies
Critical review of past learning experiences	Self	To look over or examine self-performance. This includes: • Learning strengths and weaknesses, • Setting or tracking learning goals, • Learning styles such as visual, auditory and tactile.	Lew & Schmidt, 2006; Moon, 1999
	Peers	To look over or examine peers' performance. This includes: • Team work, and team dynamics, i.e. cooperativeness and level of contributions, • Helping peers with their learning, or seeking help from peers.	
	Products	To look over or study the products of learning, which emerged as a result of relating knowledge structures from text. This includes: • Domain-specific skills, e.g.: graph-plotting using Microsoft Excel, Visual Basics programming, Microsoft PowerPoint etc. • Presentation slides, self-created computer programs, self-creating Excel accounting spreadsheets, classroom performance grades etc.	
Cognitive learning strategies	Rehearsal	Oral repetition, copying, making selective verbatim responses and underlining the important parts of the material	Weinstein & Mayer, 1986
	Organization	Categorizing information, creating knowledge networks and hierarchies (e.g. mind maps)	
	Elaboration	Creating analogies or mental images, generative note taking and self-questioning.	
Summaries of what was learnt	–	To relate new information to prior or existing knowledge; applicability of knowledge gained to other situations.	Selfe et al., 1986; Woodward, 1998

'small', .50 should be regarded as 'medium' and an effect size of .80 should be regarded as 'large'. Furthermore, a positive effect size represents improvement whilst a negative effect size indicates deterioration.

Results

Descriptive statistics for the number of instances with which each textual category generated by text appeared in student reflection journals are given in Table 2. The findings suggest that students reflected on three general categories related to their learning in their journal responses: critical review of past learning experiences, learning strategies and summaries of the contents of what was learnt. Students appeared to focus most on reflecting on their learning behaviours and performance. Furthermore, students seemed to focus least on reflecting the content of what they had learnt, as indicated by the low frequency counts of the 'summaries of what was learnt' category. The means between the categorical frequency counts in student journal responses obtained in weeks-13 and -14 were tested for significant differences using paired-samples *t*-tests and the results contained in Table 2. The computed effect sizes are also contained in this Table.

The outcomes of the analyses demonstrate that the differences between the two data sets were statistically significant. Absolute Cohen's *d* values ranging from 0.16 to 0.80 were obtained, suggesting small to large effect sizes. Furthermore, a mixture of both positive and negative effect sizes were obtained based on the magnitude in the difference in categorical means, indicating that students appeared to reflect and write more about certain aspects of their learning in their journals and less so in other areas as they progressed through the academic year.

Discussion

The present study was conducted to examine student journals for evidence of reflective activities and whether students show improvements in their reflective skills through continuous engagement in journal writing as they progressed through the academic

Table 2. Descriptive statistics, outcomes of paired-sample *t*-tests and effect sizes of frequency counts for categories present in student journal responses.

	Week-3		Week-14		Paired-samples *t*-tests	Effect size
	Mean	*SD*	*Mean*	*SD*	*t* value	Cohen's *d*
Critical review						
Self	4.40	2.93	6.42	2.04	4.43*	0.80
Peers	6.50	2.15	5.43	2.48	5.62*	−0.46
Products	5.79	3.48	8.73	4.44	5.30*	0.74
Cognitive learning strategies						
Rehearsal	4.02	1.33	5.74	2.91	4.38*	0.76
Organization	2.87	1.86	3.89	1.35	8.41*	0.63
Elaboration	1.34	1.91	2.37	1.88	5.58*	0.54
Summaries of what was learnt	4.36	2.81	2.87	1.15	4.34*	−0.69

Notes: *SD* = standard deviation; degrees of freedom = 3459; *p < .01, 2-tailed.

year. To that end, we attempted to code the reflection journals written by students in an objective fashion, by means of an automated content analysis approach using software. We were interested to find out whether students' journals, in agreement with what the literature suggests, focus on critical reviews of their own and/or that of their peers' processes of learning and behaviours and understanding of learning strategies used to enhance their metacognition. Furthermore, we were interested to find out to what extent students use reflection journals to summarize the content of what they have learnt. This is considered by some as ineffective in enhancing students' reflective abilities, as it is thought to hinder the objective of developing critical thinking and meta-cognitive skills (Langer, 2002; Voss, 1988).

The outcomes of the text analyses suggest that there is evidence of reflection in students' reflection journals. They appeared to reflect on three general categories related to their learning: critical review, learning strategies and summaries of what was learnt. Descriptive statistics of the mean categorical counts suggest that students focused most on reflecting on their learning behaviours and performance. Furthermore, students seemed to focus least on reflecting on what they have learnt at particular points in time. In addition, the number of reflective activities increased as the year progressed, as indicated by the significant differences between the mean frequency counts for the three general learning categories found in student journal responses. This suggests that some learning took place during the course of the academic year, such as in the area of enabling students to become better aware of their learning. Students appeared to show more engagement in critical reviews about the processes of their own learning and behaviours and demonstrated a better understanding of their ability to transform their own learning strategies. This concurs with what the literature reports about the role of reflection journals in enhancing students' awareness of their cognitive processes and their control of these processes (McCrindle & Christensen, 1995; Vockell, 2004). By contrast, students showed fewer tendencies to summarize the content of what they had learnt, as indicated by the significant decrease in the mean frequency count for the category on 'Summaries of what was learnt' as the academic year progressed. This suggests that some learning took place, since students restating in their own words what was learnt is considered by some as ineffective in enhancing students' reflective abilities, as it is thought to hinder the objective of developing critical thinking and metacognitive skills (Langer, 2002; Voss, 1988).

Implications of the findings

What do these findings imply? First, there is the possibility that our results were somewhat coincidental despite finding significant differences. The reader may remember that students write reflection journals in response to a question of their tutor. These questions differ each day and they also differ between tutors. Therefore, the differences between responses in weeks-3 and -14 may be caused by differences in the particular questions asked. To test whether the difference in reflection on learning as a function of time was influenced by the specific tutor-asked questions, we subjected all questions asked in both weeks-3 and -14 to text analyses using the same content analysis approach of student journal responses. In total, more than 1000 journal questions were asked by approximately 250 tutors involved in taking first-year classes. Identical categories (e.g. learning strengths and weaknesses, learning goals, collaborative learning etc.) were generated for both data sets. Comparisons between the means of the frequency counts for the categories by means of paired sample *t*-tests revealed that none of

their differences were statistically significant. Therefore, the increase in the amount of reflection in students' journals cannot be explained away by differences in questions asked.

A second possibility is that the findings are time-dependent, viz., the results obtained would have been different if student journal responses from other weeks of the academic year had been used in the content analyses. To test this hypothesis, we examined, post-hoc, more than 20,000 student journal responses written in two other weeks, i.e. week-4 of the first semester and week-15 of the second semester. Identical categories to those contained in Table 1 were generated. Similar to the results obtained from the data sets from weeks-3 and -14, test of differences between the mean categorical frequency counts by means of paired-sample t-tests revealed no significant differences (for example, Critical review [self] = $t[3459] = 1.49$, $p < .01$; Learning strategies [organization] = $t[3459] = -2.32$, $p < .01$; Summaries of what was learnt = $t[3459] = 1.57$, $p < .01$, with degrees of freedom in brackets). This suggests the measurement stability of our findings, since the results from content analyses using data from other weeks of the academic year were similar to those obtained from the data sets from weeks-3 and -14.

A third factor potentially affecting our findings is that the presence of spelling and grammatical errors may have influenced the outcomes of the resulting categories to some extent. An increase in the number of errors over time may have increased that number of responses per category by the text analysis program. If, for instance, students wrote shorter sentences to a larger extent in week-14 and these shorter sentences were grammatically more often incorrect because they were shorthand rather than full sentences, the number of responses may have increased. This arises because of a limitation of the text analysis software, which could not detect the presence of wrongly spelt words. For instance, misspelt terms such as 'teamwk' (instead of 'teamwork') and 'grp' (instead of 'group') were extracted and counted towards the categorical count of Critical review (peers). To test this hypothesis, a random sample of 500 first-year students was first selected. The spelling errors in the reflection journals (over 1000 responses from week-3) of these students were first corrected for spelling errors before they were subjected to text analyses. The analyses generated identical categories to those contained in Table 1. Test of differences between the mean categorical frequency counts by means of paired-samples t-tests revealed no significant differences between the data set from this random sample and that from week-3 (for example, Critical review [self] = $t[499] = -1.29$, $p < .01$; Learning strategies [organization] = $t[499] = 0.31$, $p < .01$; Summaries of what was learnt = $t[499] = 0.76$, $p < .01$, with degrees of freedom in brackets). Therefore, writing errors do not seem to affect the outcomes of the text analyses.

Conclusion

In summary, our findings indicate that there is evidence of reflection in student journal responses, in accordance with what several authors emphasized: reflection journals, by focusing on the *processes* (e.g. self-reflection and learning strategies) rather than the products (e.g. summaries of knowledge acquired) of learning, may enable students to improve on their reflective capacity and skills (Haigh, 2001). The findings further suggest that students show improvements in their reflective skills through journal keeping. Students' awareness of how they learnt improved as they progress through the academic year. Similar results were also found in the study by Dart et al. (1998).

Although the findings from the present study seem to concur with the literature on reflective journal writing, the results from existing studies were more subjective, since they involved manual coding of student journal responses. In addition, existing studies did not include comparison of findings over time, casting some doubts over the reliability and validity of their results.

Contrary to most studies in journal writing with limitations such as small sample size, non-continuous engagement in the task of writing journals or infrequent feedback given by teachers, the present study has sought ways in arriving at more reliable and valid measurements. We did not rely on single reflection journals of students and adopted an automated coding procedure, where the categories were derived based on findings in the literature of the positive effects of journal writing on student learning. As such, the problem of inter-coder reliability was absent. Furthermore, in this context, students received continuous feedback on their behaviours and learning from their tutors. The provision of such regular and timely feedback may have created optimal conditions for enhancing students' awareness of how they learnt, given that they receive explicit cues and suggestions from their tutors on how they can further improve.

Limitations

Some limitations should, however, be noted. The text analysis software is not a panacea and, although using software to perform content analysis removes inter-coder reliability as a concern, it is not without its shortcomings. In human coding, the coders read the responses and can capture all the nuances of a statement even if they face difficulties applying the coding categories. The software can apply the coding categories, but they need to be defined so that the nuances are captured. An implication arising from this is that the editing done by the researchers of the synonyms and excluded words in the various libraries must accurately capture the ideas of the respondents in the text. Another limitation of the software is that it will not capture all the information in the journal responses, although categories can be created easily without any intervention on the part of the researchers.

Further research

Two studies present themselves for future research based on the findings from the present study. First, given that there is evidence of learning in student reflection journals, students' academic performance would be expected to improve. Thus, examining the effects of journal writing on academic achievement should constitute the next stage of research. Second, further research should investigate if student writing skills can be improved through formal training in journal writing. Through a more structured and closely guided process, not only might students' ability to write improve, they might also become better metacognitive and self-reflective learners, a skill so valued in professional practice.

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