

## **Using learning dimensions within the Effective Lifelong Learning Inventory (ELLI) as indicators of academic success in Biosciences**

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### ***Abstract***

The Effective Lifelong Learning Inventory (ELLI) was developed by the University of Bristol and aimed to raise students' awareness of their own learning power; summarised in seven key dimensions related to the learners' dispositions, attitudes and behaviours associated with learning (Deakin-Crick and Small, 2006; Deakin-Crick, 2007; Deakin-Crick, Broadfoot and Claxton, 2004).

This study used ELLI with level 4 and level 6 cohorts in Biosciences programmes at Northumbria University as an indicator of academic performance. The dimension with the highest mean score for level 4 students was 'meaning making', followed by 'changing and learning'. 'Creativity' had the lowest mean score. Students were divided into two groups with respect to their academic achievement; the 'successful' and the 'satisfactory' group. The successful group scored higher in all dimensions, compared to the satisfactory group. The differences in the scores for 'meaning making' and 'creativity' were statistically significant. Large differences were also found for 'changing and learning', 'strategic awareness' and 'resilience'. Interestingly, all of these, with the exception of 'meaning making', were also the dimensions for which Level 6 students scored higher than Level 4 students, but the differences were not statistically significant.

Results indicated that ELLI is a useful tool for identifying key dispositions in successful learners, which could inform interventions to improve learning within a cohort.

**Keywords:** ELLI; student achievement; student success; student learning.

## ***Introduction***

Lifelong learning is a term that has been used widely in a variety of contexts. It has been described as continuous, deliberate, self-directed learning (Simper et al., 2016) using learning opportunities afforded throughout life. According to the developers of ELLI (Deakin-Crick et al., 2004; 2013) it is influenced by the learning power summarised in the seven key dimensions discussed in this report. These are essential attributes for biosciences graduates, given the rapidly evolving nature of biological sciences and the rapidly changing employment market. This is reflected in the recently revised 'subject benchmark statements for Biosciences' (QAA, 2015) which state that, in addition to the subject-specific knowledge and skills, biosciences graduates should demonstrate well-developed lifelong learning strategies for continually updating and enhancing their knowledge and effective time management, organisational, enterprise and knowledge transfer skills to enable them to complete complex and challenging tasks.

Lifelong learning power has been usually discussed in terms of capabilities and dispositions (Smith and Spurling, 1999; Carr and Claxton, 2002; Entwistle and McCune, 2013), where the former includes the skills and strategies required for learning and the latter involves characteristics that enable the learner to be ready and willing to take learning opportunities, such as 'habits of mind, tendencies to respond to situations in certain ways' (Katz, 1988, p.30), in addition to a level of metacognition and 'disposition to understand for oneself' (Entwistle and McCune, 2013, p.277). All of these are complex concepts, difficult to quantify.

Deakin-Crick and colleagues (Deakin-Crick and Small, 2006; Deakin-Crick et al., 2015) validated the Effective Lifelong Learning Inventory (ELLI) as a reliable tool for measuring learning power, without specific reference to disciplines. The ELLI is an online self-reporting questionnaire with 72 questions about behaviours, attitudes and feelings related to learning. The associated software converts the answers into scores from 0 to 100 for seven dimensions: changing and learning, critical curiosity, meaning making, creativity, resilience, strategic awareness and learning relationships, defined as shown in Table 1 (Deakin-Crick and Small, 2006; Deakin-Crick et al., 2015).

The ELLI was used both for raising learners' awareness of their own strengths and weaknesses and for enabling academic staff to 'measure' the learning power of a cohort, identify elements essential for effective learning and devise suitable pedagogical interventions to improve achievement (Deakin-Crick et al., 2004; Deakin-Crick and Yu, 2008; Deakin-Crick et al., 2013).

In this study, the ELLI questionnaire was used as an assessment tool to explore differences in dispositions between learners with different academic achievements among level 4 (first year) and level 6 (final year) students on Biosciences programmes at the University of Northumbria. The aim was to identify dispositions and attributes of successful learners and use these to devise strategies to boost weaker dimensions and improve learning in weaker members of the cohorts, to improve retention and progression and enhance graduate employability.

Academic success has been attributed to many factors, such as economic, social, cognitive, gender, and approaches to learning (Cattell 1965; Jacobs et al., 1996; Mills et al., 2009; Biggs and Tang, 2011; Herrmann et al., 2016), but there is less clear evidence to link learning dispositions to academic success. It would be pertinent, therefore, to examine the qualities and dispositions of effective successful learners, as measured by the ELLI.

## ***Methodology***

### **2.1 Study design**

This was an exploratory study conducted by invitation of first year students on the Biomedical Sciences and Human Biosciences programmes at the University of Northumbria to complete the ELLI questionnaire online. The idea was to gain an insight into their learning power at the point of entry and relate their scores to academic achievement as they progressed through their course. Final year cohorts were also invited to take part. All cohorts are referred to as Biosciences students throughout this report. Students were briefed and alerted to the ELLI tool during the induction week in September 2011, using the definitions of the seven learning dimensions presented in Table 1. They were consented and offered registration on the first week of teaching. Their scores were discussed shortly afterwards in individual tutorials and related to individual study plans.

The cohort outcomes were discussed with the programme teaching teams in module and programme evaluation meetings.

**Table 1. The Effective Lifelong Learning Inventory (ELLI) - brief definitions of the seven key dimensions (Deakin-Crick and Small, 2006; Williamson et al., 2012).**

| Dimension                   | Definition   |
|-----------------------------|--|
| Changing and Learning (CL)  | A sense of yourself as someone who learns and changes over time; the opposite is being 'stuck and static';   |
| Critical Curiosity (CC)     | An orientation to want to 'get beneath the surface'; the opposite is being 'passive';  |
| Meaning Making (MM)         | Making connections and seeing that learning 'matters to me'; the opposite is simply 'accumulating data';   |
| Creativity (CR)             | Risk-taking, playfulness, imagination and intuition; the opposite is being 'rule-bound';   |
| Resilience (RS)             | The orientation to persevere in the development of your own learning power and relish challenge; the opposite is being 'fragile and dependent';                        |
| Strategic Awareness (SA)    | Being aware of your thoughts, feelings and actions as a learner and able to use that awareness to plan and manage learning processes; the opposite is being 'robotic'; |
| Learning Relationships (LR) | Learning with and from others and also being able to learn alone; the opposite is either being 'isolated' or 'over-dependent'.   |

## 2.2 Ethical considerations

In compliance with Northumbria University ethical guidelines on working with human subjects, a series of documents were prepared including a participant information sheet, consent form and an invitation letter to participate in the study. Participants were assured anonymity, privacy and confidentiality in handling their data. Written consent was obtained from each participant.

## **2.3 Data collection and analysis**

23 first year students were consented and 19 of them completed the ELLI questionnaire. 5 final year students completed the questionnaire. Data was summarised in the form of a spider diagram (Microsoft Excel). The individual scores were used in subsequent statistical analysis. Students were assigned to two groups with regards to their achievements at the point of progression to second year. The 'successful' performance group achieved first or upper second class, and the 'satisfactory' group achieved lower second or third class level averages of marks.

All the descriptive and hypothesis testing statistics were carried out using SPSS for Windows V.21 software, at  $p < 0.05$  level of significance. The scores for the seven dimensions were compared using one-way ANOVA with post-hoc tests. The ELLI scores of Level 4 and Level 6 students, and of the 'successful' and 'satisfactory' groups were compared using the independent samples t-test. The strength of the relationships between ELLI scores and level averages of marks was analysed using Pearson's correlation. The changes in average marks from Level 4 to Level 5 and 6 were analysed using the paired samples t-test.

## **Results**

### **3.1 Comparison of learning power of first year (level 4) and final year (level 6) students**

The results are summarised in Table 2. For first year students the learning dimension with the highest mean score was MM followed by CL and CC. The mean scores for MM, CL and CC were not significantly different to each other, but all were significantly higher than CR, which was the dimension with the lowest mean score. MM was also significantly higher than the mean scores for RS, LR and SA. There were large differences between the individual student scores, as measured by the relatively large standard deviations and the broad ranges of variation for each learning dimension.

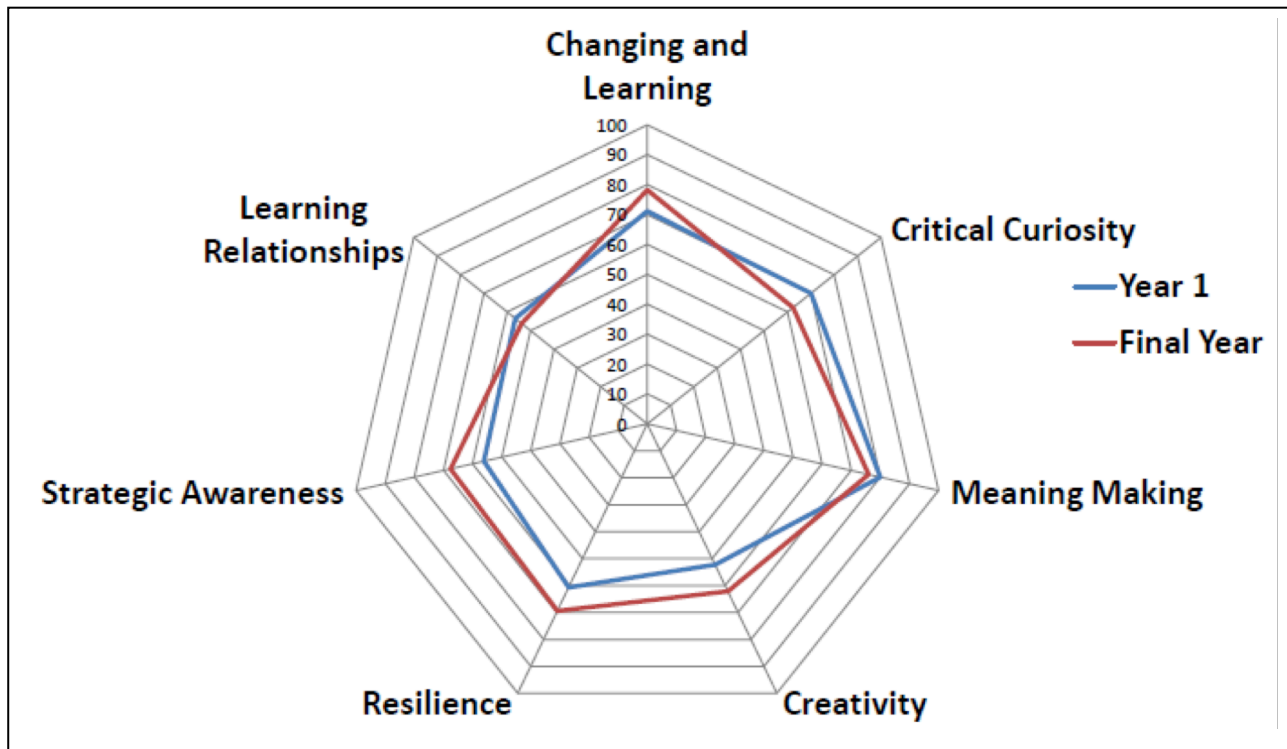
The overall average ELLI score of final year students was  $67.1 \pm 14.9$  which was slightly higher than that of the first year of  $63.8 \pm 19.6$ , but the difference was not statistically significant (independent t-test, at  $p < 0.05$  significance). The data presented in Table 2

were used to construct spider diagrams (Figure 1) to illustrate the differences in learning dimensions between first year and final year students. There were a few interesting differences: final year students had higher mean scores for CL (+7.1), CR (+9.9), RS (+8.7) and SA (+11.5), and lower mean scores for CC (-7.6), MM (-4.0) and LR (-2.7). However, none of these differences were statistically significant (independent t-test, at  $p < 0.05$  level).

**Table 2. Analysis of the ELLI scores for Biosciences students by year of study (mean scores  $\pm$  standard deviations; the dimensions are arranged in increasing order of scores; the letters a, b, c show which of the numerical differences between dimension scores were significant, based on the outcome of one-way ANOVA, with post-hoc tests, at  $p < 0.05$  level of significance).**

| Year of Study        | Learning Dimension (mean score $\pm$ standard deviation)  |                                   |                                    |                                   |                                    |                                   |                                   |
|----------------------|---|-----------------------------------|------------------------------------|-----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|
|                      | CL<br>Changing and Learning   | CC<br>Critical Curiosity          | MM<br>Meaning Making               | CR<br>Creativity                  | RS<br>Resilience                   | SA<br>Strategic Awareness         | LR<br>Learning Relationships      |
| First Year<br>(n=19) | 71.1<br>( $\pm 20.9$ )<br>[17-100]  | 70.0<br>( $\pm 13.1$ )<br>[48-96] | 80.0<br>( $\pm 12.3$ )<br>[52-100] | 52.3<br>( $\pm 19.5$ )<br>[10-97] | 60.7<br>( $\pm 18.7$ )<br>[33-100] | 56.1<br>( $\pm 22.0$ )<br>[17-83] | 56.5<br>( $\pm 14.6$ )<br>[22-82] |
|                      | <b>CR &lt; SA &lt; LR &lt; RS &lt; CC &lt; CL &lt; MM</b><br>a < ab < ab < ab < bc < bc < c<br>One way ANOVA          |                                   |                                    |                                   |                                    |                                   |                                   |
| Final Year<br>(n=5)  | 78.2<br>( $\pm 12.8$ )<br>[58-92]   | 62.4<br>( $\pm 14.3$ )<br>[41-78] | 76.0<br>( $\pm 3.5$ )<br>[71-81]   | 62.2<br>( $\pm 17.3$ )<br>[37-80] | 69.4<br>( $\pm 15.1$ )<br>[47-84]  | 67.6<br>( $\pm 9.7$ )<br>[51-74]  | 53.8<br>( $\pm 18.6$ )<br>[33-75] |
|                      | <b>LR &lt; CV &lt; CC &lt; SA &lt; RS &lt; MM &lt; CL</b><br>One-way ANOVA (no significant difference at $p < 0.05$ ) |                                   |                                    |                                   |                                    |                                   |                                   |

**Figure 1. Comparison of the mean ELLI scores of first and final year Biosciences students (n=19 for Year 1; n=5 for Final Year).**



### 3.2 Analysis of marks

The average marks at the end of all years of study completed up to the point of analysis were recorded, based on the summer progression and awards board reports for all students who completed the ELLI questionnaire (Table 3).

The academic performance of the students who completed the ELLI questionnaire at the beginning of their first year decreased significantly from first year to second year (paired t-test,  $p < 0.05$ ), from an upper second class to a lower second class average. The academic performance of those who completed the ELLI questionnaire during their final year was also poorer at second year, decreasing from a lower second class in first year to a third class average in second year, followed by an increase back to lower second class average in final year (differences not significant). Of the 5 final year students who participated in this study, one obtained upper second class, three obtained lower second class and one obtained a third class degree, all BSc Honours degrees.

**Table 3. Indicators of academic performance at different levels of study.**

| Year of study | Avg Marks first year | Avg Marks second year | Avg Marks final year | Stat Analysis   |
|---------------|----------------------|-----------------------|----------------------|---|
| Year 1        | 63.5 ± 6.9           | 55.6 ± 7.6            | n/a                  | p < 0.05<br>significant<br>decrease from 1 <sup>st</sup><br>to 2 <sup>nd</sup> year |
| Final Year    | 51.2 ± 6.5           | 49.2 ± 3.3            | 54.8 ± 5.7           | changes not<br>significant at<br>p<0.05   |

### 3.3 Correlation analysis of ELLI scores and academic performance

In an approach to identify which of the ELLI learning dimensions was the best predictor for academic success, the ELLI individual scores of students were tested for correlation with their respective level averages of marks.

For the first year students the dimensions with the strongest positive correlations were CR (1<sup>st</sup> year marks) and SA (2<sup>nd</sup> year marks) (Table 4A). For the final year students, LR, RS and MM were the dimensions with the highest positive correlations with the marks. None of these correlations were significant at p<0.05 level (Pearson's correlation test).

**Table 4A. Summary of the correlation analysis of marks against academic achievement for first year students.**

| ELLI Dimension        |                       | 1 <sup>st</sup><br>year<br>marks | 2 <sup>nd</sup><br>year<br>marks |
|-----------------------|-----------------------|----------------------------------|----------------------------------|
| Changing and Learning | Pearson's correlation | .266                             | .049                             |
|                       | p value (2-tailed)    | .258                             | .856                             |
|                       | N                     | 18                               | 16                               |
| Meaning Making        | Pearson's correlation | .254                             | .305                             |
|                       | p value (2-tailed)    | .309                             | .251                             |
|                       | N                     | 18                               | 16                               |
| Critical Curiosity    | Pearson Correlation   | -.038                            | .026                             |
|                       | p value (2-tailed)    | .888                             | .924                             |
|                       | N                     | 18                               | 16                               |
| Creativity            | Pearson's correlation | .364                             | .285                             |
|                       | p value (2-tailed)    | .137                             | .285                             |
|                       | N                     | 18                               | 16                               |



|                        |  |                    |                    |
|------------------------|--|--------------------|--------------------|
| Resilience             | Pearson's correlation<br>p value (2-tailed)<br>N | .081<br>.750<br>18 | .196<br>.466<br>16 |
| Strategic Awareness    | Pearson's correlation<br>p value (2-tailed)<br>N | .111<br>.662<br>18 | .443<br>.086<br>16 |
| Learning Relationships | Pearson's correlation<br>P value (2-tailed)<br>N | .176<br>.484<br>18 | .308<br>.247<br>16 |
| ELLI Avg               | Pearson's correlation<br>p value (2-tailed)<br>N | .244<br>.329<br>18 | .370<br>.159<br>16 |

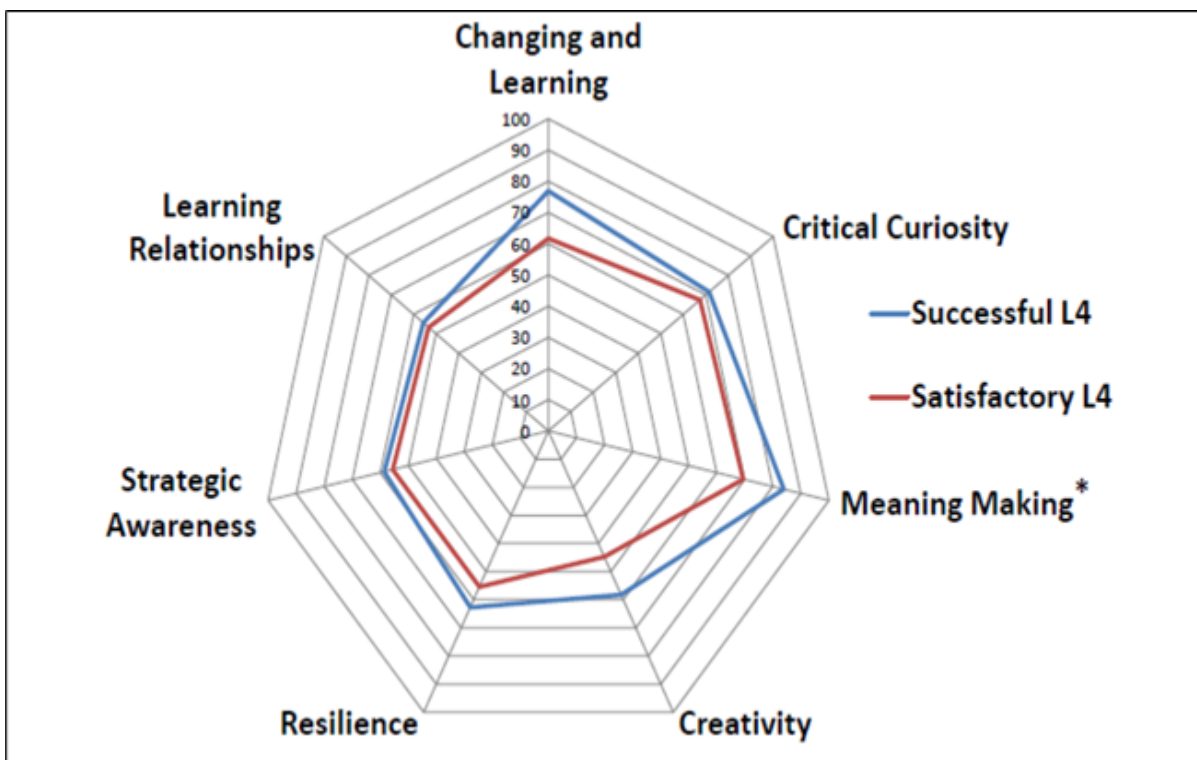
**Table 4B. Summary of the correlation analysis of marks against academic achievement for final year students.**

| ELLI Dimension         |  | 1 <sup>st</sup><br>year<br>marks | 2 <sup>nd</sup><br>year<br>marks | Final<br>year<br>marks |
|------------------------|--|----------------------------------|----------------------------------|------------------------|
| Changing and Learning  | Pearson's correlation<br>p value (2-tailed)<br>N | -.094<br>.881<br>5               | .169<br>.752<br>5                | -.781<br>.119<br>5     |
| Meaning Making         | Pearson's correlation<br>p value (2-tailed)<br>N | -.381<br>.527<br>5               | -.649<br>.237<br>5               | .436<br>.463<br>5      |
| Critical Curiosity     | Pearson's correlation<br>p value (2-tailed)<br>N | .198<br>.750<br>5                | -.045<br>.943<br>5               | -.248<br>.688<br>5     |
| Creativity             | Pearson's correlation<br>p value (2-tailed)<br>N | -.739<br>.153<br>5               | -.803<br>.102<br>5               | .244<br>.692<br>5      |
| Resilience             | Pearson's correlation<br>p value (2-tailed)<br>N | -.474<br>.420<br>5               | -.855<br>.065<br>5               | .443<br>.455<br>5      |
| Strategic Awareness    | Pearson's correlation<br>p value (2-tailed)<br>N | -.169<br>.786<br>5               | -.658<br>.227<br>5               | .379<br>.529<br>5      |
| Learning Relationships | Pearson's correlation<br>p value (2-tailed)<br>N | .479<br>.414<br>5                | -.192<br>.757<br>5               | .510<br>.380<br>5      |
| ELLI Avg               | Pearson's correlation<br>p value (2-tailed)<br>N | -.219<br>.724<br>5               | -.661<br>.224<br>5               | .218<br>.725<br>5      |

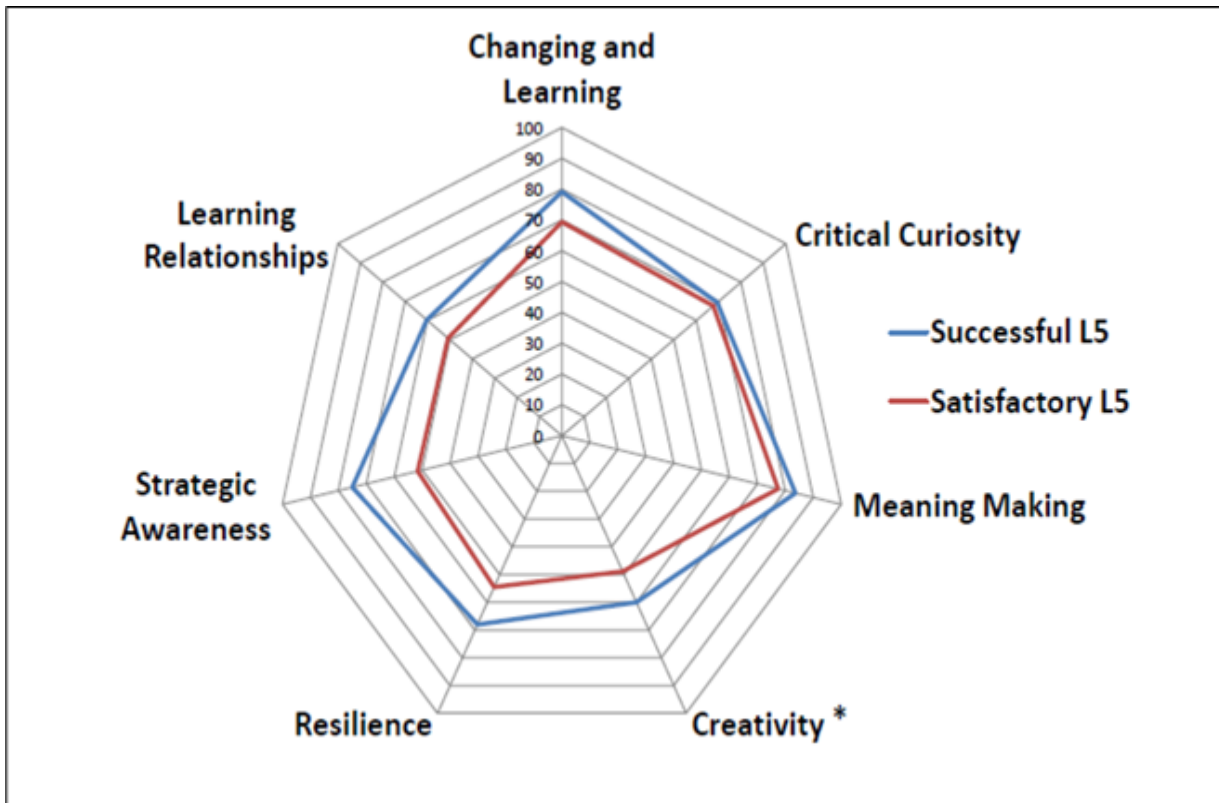
### 3.4 Analysis of ELLI scores in relation to academic success

In an attempt to identify which learning dimension might be a good predictor for academic success, ELLI scores for the ‘successful’ group were compared to those in the ‘satisfactory’ group. This analysis excluded the ELLI scores of those who failed the first or the second year. Students in the ‘successful’ group had higher scores than those in the ‘satisfactory’ group for all learning dimensions. When students were split based on the first year results, the largest differences were seen for MM (+ 15, significant at  $p < 0.05$ ), CL (+15, n.s.) and CR (+14, n.s.) (Figure 2A). When the same students were split based on their second year results, the largest differences in ELLI scores were for SA (+23, n.s.), RS (+14, n.s.), and CR (+11, significant at  $p < 0.05$ ) (independent samples t-test) (Figure 2B).

**Figure 2A. ELLI scores of students who completed the ELLI at the beginning of their first year, split by the academic performance at end of first year (level 4); Successful group n = 13; Satisfactory group n = 5. Significant difference indicated by (\*).**



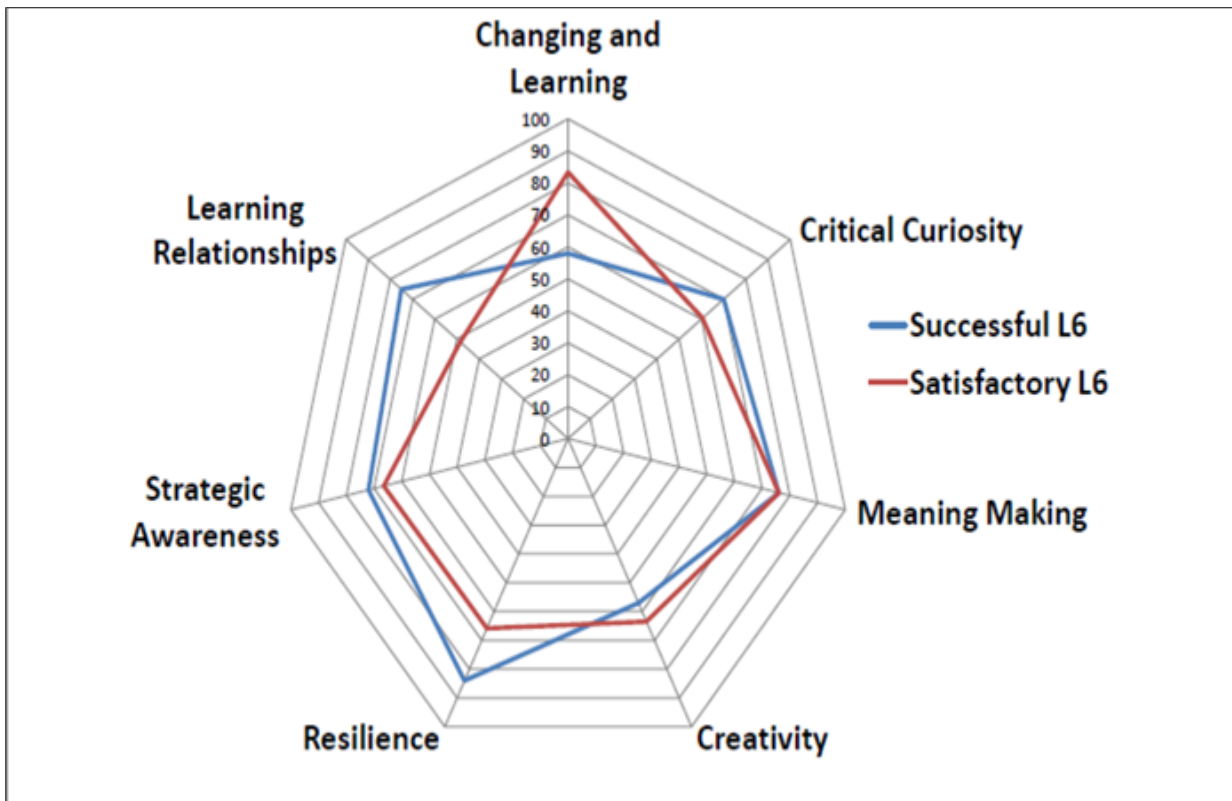
**Figure 2B. ELLI scores of students who completed the ELLI at the beginning of their first year, split by the academic performance at end of second year (level 5); Successful group n = 4; Satisfactory group n = 12. Significant difference indicated by (\*).**



All students who completed the ELLI questionnaire during their final year fell into the ‘satisfactory’ academic performance group based on their average marks at the end of the first and second years, therefore they could not be split into different academic performance groups at those levels. Figure 3 shows the average ELLI scores, by dimension, of those in the ‘satisfactory’ group (n=4), compared to the scores of one student who fell into the ‘successful’ academic performance group at level 6.

The successful student’s profile showed higher scores in LR, SA and RS. Interestingly, the lowest of her/his scores was in the CL compared to the satisfactory group. The differences were not statistically significant.

**Figure 3. ELLI scores of students who completed ELLI questionnaire during their final year (level 6), split by academic performance; Successful group n = 1; Satisfactory group n = 4.**



## **Discussion**

Students who participated in the ELLI study had completed their GCE A Level, with the exception of one adult student who completed a Higher Education Foundation Course at a local college. Entrants face the need to adapt to university life and cope with the demands of the Biosciences programmes. Developing competences to deal with such challenges includes, in addition to knowledge acquisition, personal qualities and dispositions (Haste, 2001; Hoskins and Deakin-Crick, 2010). We wanted to explore such dispositions and relate them to the ELLI scores in different dimensions.

The mean ELLI scores for level 4 students in this study (Table 2) were similar to those reported by Deakin-Crick and Yu (2008) in adult learners and those from a collaborative project that included 11 universities in addition to Northumbria (Small and Deakin-Crick, 2008, Williamson et al., 2012). These studies reported higher scores for MM and CL and

lower for CR and RS. First year students in this study were able to make connections between previous and newly acquired knowledge, and show the capacity to change. The latter was often emphasised by students in vocational courses (Harding and Thompson, 2011). ELLI profiles were discussed individually with the participants in tutorials shortly after completion of the questionnaires. It has prompted a process of reflection on their learning dimensions, and an understanding of attributes linked to learning. The overall outcomes were also discussed with the programme teaching team in order to find ways to boost weaker learning dimensions within a cohort.

Initially we tried to explore whether there was a correlation between ELLI scores and students' average marks at levels 4 and 5. No such correlation was found in this study, similar to the findings reported by Harding and Thompson (2011) for a larger scale study. The decrease in marks from Level 4 to Level 5 shown in our study is a recurring feature with Biosciences students and could be due to the increase in the demands of the course and complexity of assessment at level 5. Students' achievements usually improve at level 6, when they get better at skills such as time management and organisation and are more motivated to do well.

We went on to explore whether the ELLI scores could be used to identify dispositions of successful learners by comparing the 'successful' and 'satisfactory' academic achievement groups. Our results indicated higher mean scores in all ELLI dimensions in the successful group, with significant differences for MM and CR. Harding and Thompson (2011) reported that one of the ELLI dimensions with the strongest correlations to academic achievements in university students was MM. Successful students tend to be better at forming relationships to advance their learning, handling challenges, developing mechanisms to cope with course demands, and being aware of course requirements and their own abilities to meet them. These are components of self-regulated learning (Flavell et al., 2002), which could help students to self-monitor and evaluate previous and current learning and subsequently change their thoughts and actions to achieve independent academic goals (Zimmerman, 2002; Deakin-Crick et al., 2015). A study on postgraduate medical students showed that their highest scores were for MM and CL, the lowest for CR and RS and only the students with high grades (the 'successful' group) displayed significant improvements in the mean ELLI scores by the end of the first term of

postgraduate study for all ELLI dimensions apart from RS. Those with lower grades made declines in scores for several dimensions (Rashid-Doubell and Cuculescu-Santana, 2012). Successful students at the end of the first year were able to relate their learning to previously acquired knowledge and construct meaning (Biggs and Moore, 1993). Such students are more likely to adopt a deep approach to learning. Knapper and Cropley (2000) emphasised that a deep approach to learning is integral to lifelong learning, which is related to the personality dimension of need for cognition (Cacioppo et al., 1996) and strategic flexibility in learning (Cantwell and Moore, 1996). Creativity has been seen as ways of exploring ideas and testing alternative pathways related to problem-solving, which is essential for approaching problems from different perspectives (Tsai, 2012). Students who tend to be more active in their own learning seek to be creative in exploring interesting and engaging ways in their study. This involves a degree of confidence and self-belief and a capacity for unreserved involvement (Csikszentmihalyi, 1996), which could be reflected in the higher score for RS in the successful group of students in our study. Learners with CC 'try to get below the surface' and 'value getting at the truth' and are therefore more likely to adopt a deep approach to learning (Deakin-Crick, 2007, p140). Successful learners in this study scored higher in this dimension than the satisfactory group.

Only 5 students in the final year took part in the study. Their profile showed higher CL, RS, CR, SA scores than first year students, indicating a better development of learning power. Interestingly, there was a small decrease in CC. One successful student in the final year had a higher score for CL compared to the rest of the cohort. All of these differences, however, were too small to attain statistical significance.

This study has confirmed key characteristics of successful learners reported by others (Shawer, 2010; Hanscomb, 2015), that an overlap of academic skills and personal attributes is required for enhanced achievement and successful learning.

### ***Conclusions and future directions***

This study explored the relationship between the scores for the ELLI dimensions and academic success in first and final year students in Biosciences programmes. Academic success was identified as attaining a 'First' or upper 'Second' class average. Students in

the successful academic achievement group scored better in all ELLI dimension than their counterparts in the satisfactory group. Whilst the small sample size does not allow for generalisation of results, this exploratory study confirms the key characteristics of successful learners indicated by other authors, and shows that successful students displayed the largest increase in dispositions measured through the ELLI questionnaire. The authors felt that the ELLI was a useful tool for exploring learning powers specific to Biosciences. They plan to design a more discipline-specific questionnaire that could be used to increase awareness of the characteristics of successful learners in Biosciences and support learning and personal development for graduate employability in all students, but particularly in those with lower learning power at the point of entry in higher education.

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