A Longitudinal Examination of Student Approaches to Learning and Metacognition

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Student Approaches to Learning (SAL) mainly consists of two contradictory approaches (surface and deep learning) to learning that have been extensively studied in educational research. Metacognition, which refers to the process of thinking about one's thinking, has been shown to play a crucial role in helping students shift from a surface to a deep approach to learning. The current study collected data using two questionnaires (RSPQ-2F& MAI) from 1329 students. Both metacognition and learning approaches showed medium correlations and an effect of the year of study. A crossed-lagged model shows no effect of deep learning on metacognitive knowledge or regulation, although this does increase significantly over time. Overall, the study's findings suggest a complex yet clear relationship between student learning approaches and their final grade outcomes. Students will lean towards more surface learning as their (perceived) workload increases and assessments become more challenging. These findings suggest that teachers and policy makers should seek ways to increase deep learning methods, possibly using metacognitive skills training.

Keywords: metacognition, deep learning, surface learning, longitudinal data, university study

INTRODUCTION

Higher education seeks to encourage students to develop effective approaches to their learning, producing versatile graduates who can apply the knowledge gained in their studies to their careers (Lees, 2002). Teachers often assume that students will develop increasingly "sophisticated" learning strategies (such as self-regulation, metacognition, and deeper learning strategies) as they pass through university (Hofer, 2001). By the end of their studies, students should exhibit self-regulated learning behaviours acting as active agents across their own metacognitive, behavioural, and motivational learning processes (Zimmerman & Schunk, 2012). One approach to track this development could be to examine whether and how students' approaches to learning and metacognition change over time. Metacognition is defined as the intelligent monitoring and knowledge of one's own cognitive strategies (Flavell, 1979) and is a form of executive control that involves monitoring and self-regulation strategies (Schneider & Locke, 2002). Broadly speaking the definition of metacognition is the process of reflecting on and directing one's own thinking (Seraphin et al., 2012), in turn helping a learner understand and control their own cognitive processes (Jaewoo & Woonsun, 2014). By longitudinally examining student metacognition alongside their deep and surface learning approaches, teachers could have a clearer picture of student learning development patterns. Gaining this information, teachers may amend and/or improve their teaching process in order to enhance the student learning experience and improve student academic outcomes/performance.

Student Approaches to Learning

SAL appear to be a universal experience within education and have been studied worldwide in a variety of settings and subject areas (e.g., Chan, 2010; Fyrenius et al., 2007; Munshi et al., 2012; Mogre & Amalba, 2014; DeRaadt et al., 2005). Deep learning approaches encourage greater learning breadth and depth (Felder & Brent, 2005), transferring knowledge to novel situations. A deep approach is generally associated with active learning (Gomes & Golino 2014), whereas a surface approach is generally associated with passive learning processes. Surface approaches are often rooted in a desire to pass assessments whilst minimising effort, resulting in focusing on memorisation of material, which is quickly forgotten (Ramsden, 2003). Surface techniques include reviewing material the teacher presents (Waters & Watters, 2007) and passively memorising discrete facts (Stanger & Hall, 2012). These techniques are often seen in those with low academic self-confidence (Sander & Sanders, 2003) as such students tend to focus on what they believe is "productive" learning, in fact, they are merely memorizing the details. Surface learning tends to arise from motives extrinsic to the learning task, while deep learning is conversely linked to intrinsic task motivation (Phan, 2011). SAL has also been linked with other traits/characteristics such as openness (Chamorro-Premuzic & Furnham, 2009), positive emotion (Trigwell et al., 2012), and self-regulation (Heikkilä & Lonka, 2006). These characteristics have been found to be highly correlated with academic success (e.g Richardson and Bond 2012). Previous researchers have also examined students' learning approaches across various disciplines it has been found that social sciences, humanities, and the arts cultivate deeper student approaches to learning (Tomanek et al., 2002; Lizzio & Wilson, 2004), while shallower (i.e., surface) learning approaches have been documented in the fields of medicine (Rajaratnam et al., 2013) and the sciences (Lopez et al., 2013; Montplaisir, 2004; Kember et al., 2008; Watkins & Hattie, 1985).

Due to the variety of factors potentially affecting SAL, some researchers have argued for the need to consider a third approach to learning - strategic learning (Biggs et al., 2001). Whether strategic learning is in fact a separate approach or merely a subcategory of the deep learning approach remains highly debated (Richardson 2000; Zeegers 2004). This debate arises as within the literature the use of a learning approach is frequently presented as being mutually exclusive within the dichotomous scale of recognised approaches (i.e., deep vs surface level). However, when the most successful students are presented with a task, they often apply deep and surface learning techniques to utilize the advantages of both approaches (Baeten et al., 2010). Thus, when considering learning approaches as dichotomous, the nuance within SAL is overlooked (Loyens et al., 2013). Competency may also play a role in how effectively students use either approach. For example, a student following a deep approach who is not particularly competent would likely not perform as well as one exhibiting a highly organized and well-planned surface approach (Tickle, 2001). A further complicating factor is that students will tend to have an overall predisposition for their favoured learning approach, thus limiting their ability to switch between tasks requiring the application of different approaches. As such, final exam results are often lower than the student's expected grade, particularly for those with poor metacognitive awareness (Kember & Gow, 1989).

Furthermore, external factors such as the stage of learning, course topic, prior knowledge (Daly & Pinot de Moira, 2010), perceptions of teaching (Pimparyon et al., 2000), and the time point in the academic cycle could affect the use of both deep and surface approaches by students (Entwistle et al., 2000). When students first begin their studies, Elliot et al., (1999) suggested that a surface learning approach was essential for students to become accustomed to the basics and likely be the approach utilized within their initial assessments. Indeed, to develop a deeper understanding of the learning material, students first need to learn basic terms and definitions using surface approaches, such as memorizing, before they can synthesize and connect this information on a deeper level (Jehng et al., 1993). At the start of their studies, the fragmented nature of student knowledge means students are more likely to use surface strategies to make sense of the material (Alexander, 2003). Individuals with a stronger foundation of basic knowledge are more likely to achieve a deeper understanding and integration of subject material, supporting a more profound approach to learning. (Biggs & Tang, 2011)

Another factor that may lead students to adopt a learning approach, developing a potential attitude towards learning, is the study time during a demanding period. For example, Fincher et al. (2006) showed that time pressure, both actual and perceived, is one of the primary drivers leading to the increased usage of surface approach learning strategies, particularly in short, high workload periods, as such examinations (Rønning, 2009). Furthermore, this effect is even more pronounced if students consider their perceived workload inappropriate or excessive (Drew, 2001; Lawless & Richardson, 2002). The regression from deep to surface-level approaches because of time pressures has also been evidenced by Baeten et al. (2013). The researchers found students who initially exhibited high levels of deep learning approaches at the start of their studies shifted to more surface-level approaches as a likely effect of time pressure overwhelming their initial motivations to study more deeply (Baeten et al., 2013). Particularly since students attend more than one module at a time, the surface learning approach of memorization is often favored over deep learning approaches to help manage both one's workload and time (Yonker, 2011).

As well as being affected by time pressure, a SAL can vary based on the task activity, such as working on an essay or studying for an exam (Dahl et al., 2023; Hadwin et al., 2001). Due to students preferring coherence between their chosen approach and the demands of the learning environment, the approach taken is often context dependent (Entwistle & Peterson, 2004; Vermunt, 2005). Indeed, learning approaches during study periods often aim to fulfill short-term goals such as passing an examination over the longer-term aim of learning and study retention (Kornell & Bjork, 2007). Motivated by these short-term goals, Struyven, Dochy, and Janssens (2003) have suggested that students employ a learning strategy that they feel would best lead to their desired outcome. This notion was also supported by Gijbels and Dochy (2006) who found that students tended to change their approaches and implement more surface strategies after experiences with formative assessments that did not require deep learning strategies.

Therefore, following a strategic approach, students would change study processes according to their perception of assessment requirements (Marton & Säljö, 1976). This could explain why students tend to score higher than expected when using surface approaches on assignments that they *perceive* require this approach (Ngidi, 2013). This in turn may lead students to interpret the learning environment as one where a surface approach is the best learning tactic (Liem et al., 2008). Equally, students who take a deep approach to their studies prefer assessments promoting subject cognitive understanding. Including different kinds of questions, assessments might promote either a deep or a surface approach to the material a student has studied. Examinations that take the form of a Multiple-Choice Test (MCT), tend to set questions at a lower level of understanding and therefore do not require students to synthesize or apply knowledge to a deep level. When students academically succeed in using a purely surface approach (Gulikers et al., 2006; Scouller, 1998), they may become accustomed to or habitually rely on using this approach throughout their studies. Critically, students may then fail to recognize when other approaches would be of more use and adapt their learning patterns accordingly. It is, therefore important for both students and teachers to be aware of the variety of approaches available and for teachers specifically to accommodate and encourage all forms of uses.

The literature is somewhat mixed when considering the effects of learning approaches on academic achievements. Richardson, Abraham, and Bond (2012) found a deep approach to be positively correlated with Grade Point Average (GPA) in their systematic review and meta-analysis. Similarly, a range of studies have found that students focusing on a deep approach tend to be more successful academically (Duff, 2004; Zeegers 1999; Liu et al., 2015). Equally, Snelgrove and Slater (2003) found tertiary students who follow a predominantly surface approach are more likely to receive lower grades and are therefore less likely to progress to postgraduate study. Conversely, other research studies have found that surface and strategic-achieving approaches are more predictive of a higher GPA, especially in students with higher academic capabilities. This finding is possibly due to students' ability to recognize and adapt their approach to the type of assessment at hand (Ramburuth & Mladenovic, 2004; Hall et al., 1995).

Furthermore, some studies have found no relationship between the learning approach taken and one's grade (Al-Alwan, 2013; Cassidy & Eachus, 2000; Baeten et al., 2008; Gijbels et al., 2005). In his meta-analysis, Watkins (2001) examined data from 27,000 students and found weak correlations between academic achievement and SAL. Lastly, some studies have found support for both approaches. Salamonson et al., (2013), suggest that *both* deep and surface approaches are independent and significant predictors of academic performance. However, all the relationships reported were somewhat weak, reiterating our point - the literature remains mixed. One potential explanation for the contradictory findings discussed above could be that students cluster in two groups according to their approach. There is also increasing evidence that within individual course lessons (and even individual tasks), students tend to cluster into groups based on their approaches to learning (Vanthournout et al., 2009; Leung et al., 2006; Nijhuis et al., 2008).

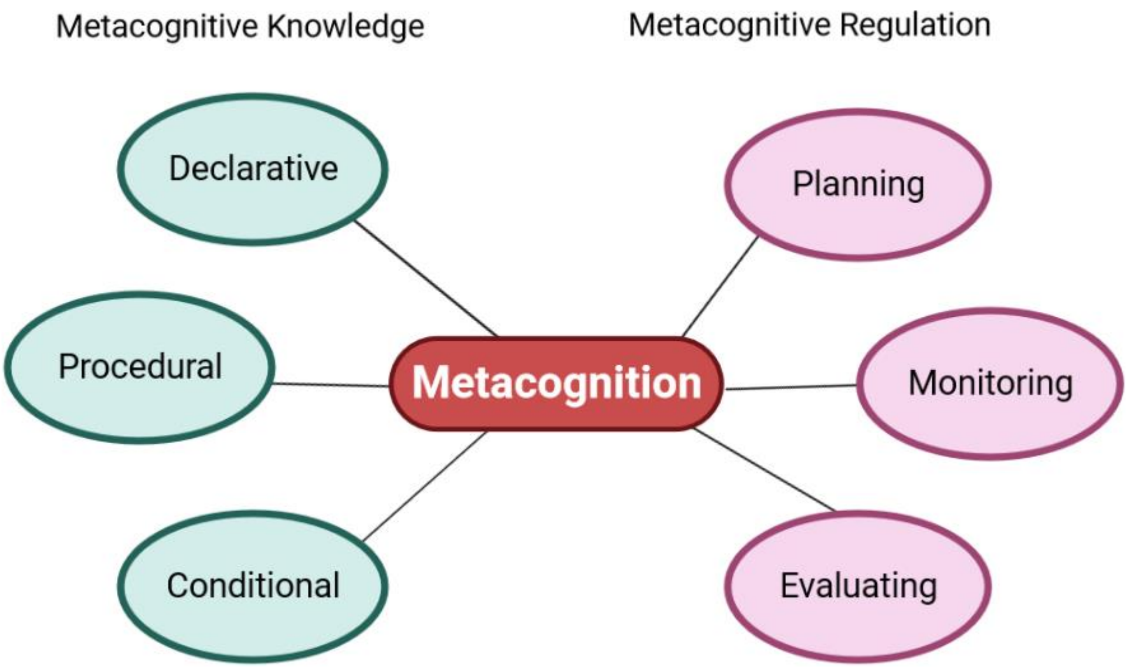
Fowler (2005) found that deep learners tended to keep their deep approach, whereas surface learners tended to adjust their approach when prompted by the learning environment. These findings suggest that learning trajectories could vary longitudinally. May et al. (2012) also found that higher-performing students tend to focus on deep learning, while those in the bottom quartile show significantly higher surface approaches. Skogsberg and Clump (2003) found no difference between upper and lower-division students suggesting that increasing topic proficiency was not necessarily accompanied by a change in the learning approach. It is possible this finding could be driven/related to changes in student metacognition (Case, & Gunstone, 2002). Studies have shown that students with good metacognition skills are more likely to review and relearn imperfectly mastered material because they can better distinguish between what they do and do not know (Everson & Tobias, 1998).

These individuals also tend to adopt a deeper approach to learning, focusing on understanding and meaning-making rather than surface-level memorization. On the other hand, individuals with weaker metacognitive skills may struggle to engage in strategic and reflective learning activities, and may instead rely on more passive learning approaches, such as rote memorization or repetition. These individuals may also adopt a more superficial approach to learning, focusing on meeting requirements or completing tasks rather than seeking a deeper understanding of the material. (Case & Gunstone, 2002). The study strategies associated with a deep approach such as reading widely and connecting with prior knowledge require students to monitor their learning process. Thus, reflecting on learning and changing such approaches based on previous experiences is only possible with a well-developed metacognitive regulation ability (Ridley et al., 1992). Metacognition and approaches to learning are strongly related to learning activities there is a strong relationship between metacognition, approaches to learning, and learning activities. This means that how individuals approach their learning is influenced by their metacognitive abilities, which in turn impact the types of learning activities they engage in. For instance, individuals with strong metacognitive skills tend to engage in more strategic and reflective learning activities, such as setting goals, monitoring their progress, and evaluating their understanding.

Metacognition

Expanding the discussion around metacognition regulation, this is only one of two theoretical areas with metacognitive knowledge being the other (see Figure 1). Metacognitive knowledge refers to students' knowledge, beliefs, ideas, and theories (Veenman et al., 2006) about people as "cognitive creatures" (Zohar, 2015, p.123). In other words, what they know about declarative, procedural, and conditional knowledge (Baker, 1991) determines task performance (Filho & Yuzawa, 2001). On the other hand, metacognitive regulation, sometimes referred to as metacognitive skill (Flavell & Miller, 2002), is a more active process that applies metacognitive knowledge to the task at hand (Pintrich et al., 2000; Poh et al., 2016). Metacognitive knowledge includes awareness about the cognitive processes one uses to learn and remember (Ormrod & Davies, 2004). Both metacognitive knowledge and regulation improve as expertise in the subject domain increases (Pressley & Ghatala, 1990). However, this can vary depending on the domain level studied (e.g., global vs course level; Winsler & Huie, 2008). The two metacognitive constructs - knowledge and regulation - are strongly correlated without a compensatory relationship. In other words, high levels in one construct do not compensate for a lack in the other (Sperling et al., 2004).

FIGURE 1
METACOGNITION BREAKDOWN MODIFIED FROM SCHRAW AND MOSHMAN (1995)



Metacognition is influenced by goals, motivations, and perceptions of ability (Mahdavi, 2014) which all feed into the learning strategies students select to use (Luwel et al., 2003). These strategies may mediate between a student's internal knowledge construction and the external coursework demands placed upon them (Akyol & Garrison, 2011). Students using deep approaches show evidence of techniques such as reflection, questioning, error detection, critiquing, and considering alternatives to their ideas. Research shows that metacognition develops partly independently of intelligence albeit to a limited extent (Berger & Reid, 1989). Therefore, it could be argued that metacognition is mediating the development of intelligence and the learning strategy adoption from students.

Biggs (1985) pointed out that inappropriate surface strategies could not result from a lack of metacognition but could be used out of habit or despair, potentially due to workload management, as discussed above. Yeşilyurt (2013) found that metacognitive awareness accompanied by an achievement-focused motivation was associated with deep learning approaches in students, while Magno (2009) found that using deep approaches accompanied by metacognitive outcomes increased student self-efficacy (confidence in ability). Thus, the conditional knowledge from this approach triggers the use of metacognitive control to select the most effective study techniques (Hadwin et al., 2001). For example, Patterson, Tormey and Richie (2014) found higher levels of student metacognition were related to a strategic approach. Indeed, a shift in learning approach can often be triggered by a combination of (both supportive or detrimental) course environments and their effect on a student's metacognitive development (Case & Gunstone, 2002).

Metacognition is not always explicit as some students struggle to explain their thinking processes (Schraw et al., 2006) coupled with the fact that it can also be difficult to teach these skills and introspection directly to students (Vos, 2001). The effort, however appears to be worth it (Schuster et al., 2020). Regardless of the subject, relevant literature suggests that explicit metacognition training can improve student performance (Thiede et al., 2003). In their meta-analysis, Donker et al., (2014) examined 95 different learning inventions and found metacognitive knowledge instruction had the greatest effect. Rezvan, Ahmadi, and Abedi (2006) found that metacognitive training was especially helpful for students in danger of losing their place at university. Latawiec (2010) suggested that metacognitive strategies could improve reading comprehension in students studying a second language. Further, Choy & Cheah (2009) suggested that the use of metacognitive scaffolding (prompts, keywords, etc.) could help students develop better metacognitive skills, especially novice learners (Lehmann et al., 2014). When students approach learning with higher metacognitive awareness, they tend to have better self-regulation skills, which may improve their academic performance (Sungur, 2007).

Metacognition has also been linked to other effective study habits such as critical thinking (Magno 2010; Lai 2011; Ko & Ho 2010), self-efficacy (Coutinho, & Neuman, 2008), self-regulated learning (Duncan & McKeachie, 2005; Marzouk et al., 2016) and spaced learning, that is repeating information and regularly spaced intervals to aid its longer-term retention (Son, 2004). Metacognition has also been linked to intrinsic factors such as a high internal locus of control (Arslan & Akin, 2014; Hrbáčková et al., 2012), self-confidence (Kleitman & Stankov, 2007), and motivation (Tobias & Everson, 2009). In Hattie's (2009) meta-analysis, teaching approaches that emphasised student metacognitive skills and self-regulated learning were among the most effective teaching approaches found, producing a mean effect size of 0.67 similar strong effect sizes have also been found by De Boer et al. (2018), and Guo (2022).

Effects of Metacognition on SAL and Metacognition Measure Tool

Having the awareness and knowledge, along with the ability to monitor, regulate, and apply appropriate learning approaches to any given task is where metacognitive functioning intersects with SAL (Baeten et al., 2010;). Through engaging in metacognitive thinking, students can assess and monitor how their current learning approach works and whether any adjustments are needed to learn and retain at a higher efficacy (Flavell, 1976) within the literature, Stanton et al., (2015) found when examining an introductory Biology class, nearly all students moderated their learning approaches in response to task demands, but their capability to monitor, evaluate, or plan their own learning strategies (i.e., attributes of poor metacognitive regulation) varied considerably. Similarly, students lacking in metacognitive knowledge can find it hard to judge accurately their (lack of) understanding (Borkowski et al., 2000). This inability hinders learning, causing students to overestimate their performance, under-prepare for examinations, poorly manage their academic performance, and increase the likelihood of dropouts (Sperling et al., 2004; Ryan, & Glenn, 2004). Perceived and actual levels of knowledge do not always align (Ziegler & Montplaisir, 2014). Students might also have different criterion tasks in mind when making metacognitive judgments (Pieschl, 2009). It is critical to note that metacognition is highly contextualized and depends on multiple factors, including the type of task students undertake, previous knowledge, and levels of task focus (Zohar, 2013). To engage in high metacognitive functioning, students must have what Pintrich and DeGroot (1990, p.39) defined as "the will and the skill". Therefore, it is important to recognize that metacognitive judgments may not always align with actual levels of knowledge and may depend on various contextual factors, as well as the individual's will and skill to engage in high metacognitive functioning. In this regard, developing self-knowledge is also critical for effective self-regulation and implementing and monitoring learning strategies. Local and global monitoring techniques can be used to measure ongoing and cumulative regulation, respectively, with students being more accurate in making global predictions about their metacognition.

Alongside this point, self-knowledge (awareness of feelings, attributes, motivations, and abilities in learning) also assists students in understanding what learning approaches work best for them to implement and monitor the effectiveness of learning strategies (i.e., self-regulate; Hayat et al., 2020). For example, students may follow local and global monitoring techniques regarding self-regulation, where students need to be aware of how they conceptualize (meta)cognition, motivation, and emotion to be strategic and successful (Panadero, 2017). Local monitoring plays a role in measuring ongoing regulation. In contrast, global monitoring is rather a measure of cumulative regulation (Young & Fry, 2008) with students tend to be more accurate when making global predictions about their metacognition (Nietfeld et al., 2005).

In an effort to assess student metacognition - and its two theoretical components of knowledge and regulation – educational researchers have used the Metacognitive Awareness Index (MAI; Schraw & Dennison, 1994). The index comprises two subscales, knowledge of cognition and regulation of cognition, containing 17 and 35-item questions, respectively. The MAI has been shown to have high validity. Schraw and Dennison (1994) found students tended to hold similar metacognitive knowledge but varied greatly in their levels of metacognitive regulation, with only knowledge of cognition scores significantly predicting test results. Young and Fry (2008) also found significant associations between MAI outcomes and grades among higher education students. Graduate students tended to show better regulation of cognition than undergraduates; however, within each group, levels of metacognitive knowledge remained stable. Supporting this differentiation, research shows experienced students tend to differ in their use of regulatory skills, such as accuracy monitoring (Schraw, 1994).

As with SALs, researchers have suggested that students could be clustered for analysis according to their metacognitive skills (Stanton et al., 2015). This clustering of different types of students potentially explains the variation in the reported effectiveness and benefits of student interventions such as study skills classes (Vermetten et al., 2002) and academic growth/development (Shivpuri et al., 2006). The picture is similarly mixed when it comes to grouping students based on their learning approaches and metacognition. Some students report changes in their metacognitive knowledge and regulation (in both directions), while others report no change (Balasooriya et al., 2009). Due to the eventual automation of metacognitive processes, it is no surprise that one's awareness decreases over time, thus explaining the fluctuations in findings. It is important to note that several unrelated variables could also moderate levels of metacognition, for example, test anxiety (Harrison & Vallin, 2018).

The methodology of cross-sectional measures and between-group comparisons used in many of the studies can be problematic because they rely on assumptions about the homogeneity of groups and the stability of responses over time. (Dinsmore et al., 2018). Examining metacognition and SAL in this way risks overlooking key determining variables, such as how academic achievement changes students' approaches over time and how learner perceptions of the situation may differ from reality (Winne & Nesbit, 2010).

Regarding the association between metacognition and academic achievement, cross-sectionally, many studies have found only a weak association between the two variables. However, some findings dispute this (see Burchard & Swerdzewski, 2009 and Landine & Stuart, 1998). Nieminen, Lindblom-Ylänne, and Lonka (2004) suggest that this weak association is due to influencing aspects of the student's experience such as assessment type, time pressures, and year of academic study. For example, the researchers found first-year students showed weak to no links between their metacognition and academic achievement, while final-year students showed a far stronger association. Longitudinally, studies have noted how the choice of learning approach interacts with metacognition and academic achievement, however, the findings on approach efficacy are mixed. According to some studies (Chen et al., 2015; Groves, 2005), there may not be a significant connection between deep learning methods and academic performance. Instead, these studies found that surface learning strategies tend to be used more frequently over time, even though they can harm final grades. In other words, while deep learning strategies may not necessarily lead to better academic achievement, surface learning strategies can hinder academic success.

Pertaining to the longitudinal changes in the learning strategy itself, the research is again mixed (see Asikainen & Gijbels, 2017 for a comprehensive review). Some studies show increases in surface learning strategies throughout students' higher education studies (Groves, 2005; Gijbels et al., 2009; Rahman et al., 2013), while others note a more curvilinear relationship. Initially, surface approaches are heavily used (Platow et al., 2013), but then decline as the course progresses, to only increase again at the end of the course (Choi & O'Grady 2011). This initial increase in surface learning might be partly due to the intuitional demands placed upon the students and their adjustment to higher education (Cano, 2005). Conversely, other studies find little support for longitudinal changes in either learning approach (Reid, et al., 2005; Herington & Weaven, 2008; Wong & Lam, 2007). This finding is thought to be due to the initial anchoring/strength of the approach most frequently used by the student. As Gijbels et al., (2008) suggest the stronger the initial approach to learning, the less likely students are to change their approach over time.

To summarise, the evidence from the literature review presented above is unclear regarding longitudinal changes within SAL, the possibility of clusters within student metacognition and learning approach. It is also important to investigate the effect of metacognitive approaches on student grades to demystify this picture.

Current Study

This study aims to examine the longitudinal changes in SAL and metacognition to help establish a clearer picture of specifically: i) how students develop metacognitively and implement different learning approaches across their studies, and ii) whether either construct influences overall academic performance. Uniquely this study looks at these possible changes across a complete Psychology degree program (i.e., three years). We hypothesize that:

H_1: *Surface learning approaches will be more prominent than deep approaches within the first semester of study.*

H_2: *The type of learning approaches used by students will change as they progress through their degree, with students in later years displaying deeper than surface learning approaches.*

H_3: *Students' metacognition will improve over time, as they develop greater awareness and the techniques to regulate their learning practices across their degree.*

H_4: *Students clustered in the category of utilising deep learning approaches and high metacognitive functioning will have the highest overall degree grade.*

METHODS

Participants and Procedure

The current study occurred in a research-focused university in the North-West of England. The Psychology degree course has a relatively large cohort, with around 1,400 undergraduate students across the three years of study. The data was gathered across two consecutive cohorts (2016/17–2017/18). All the participants were enrolled in the undergraduate psychology course (three years of studies). Demographically, the enrolled students are heterogeneous, comprising mostly UK Caucasian females between 18–23 years old (approximately 93% of the cohort). The data collected aptly reflects the course's demographics, thus suggesting the collected samples represent the institution from which they were gathered. Due to their imbalances, the following factors were not explored further: biological sex, age, and nationality.

The curricula included specific compulsory modules for the first and second years to ensure that students obtain knowledge of the psychology discipline and develop skills essential for their studies and future careers. However, in their third-year level of studies, psychology students could select from various optional modules building their year of studies based on their interest and career path that they would like to follow e.g., forensic, health, clinical and cognitive psychology. The degree programme was bps accredited and followed QAA guidelines in its development.

The recruitment process for this study started after gaining the Ethics application (Code: IHPS 396-2016; IPHS435-2016, & IPHS1369-2016) approval from the University of Liverpool. The students have been informed about this study through an email and a VLE announcement posted in the first-year research methods and statistics module. First-year undergraduate students voluntarily completed the measures during an introductory statistics class in their first week of university in 2016 providing data to form a baseline measure (n=452).

This was then followed up with a second (2016) and third (2017) wave of data collection when students of all years had the opportunity to complete the measure a second time in their lectures during weeks 4-6 in their second semester (this resulted in 140 first-year respondents, 211 second-year participants, and 141 third-year students). Unfortunately, attrition rates were high, so only 385 students completed the measures more than once across their degrees.

Materials

This study used two self-report measures: the revised two-factor study process questionnaire (R–SPQ–2F, Biggs et al., 2001) and the metacognitive awareness inventory (MAI, Schraw, & Dennison, 1994). The R-SPQ-2F consists of 20 items on a five point Likert scale with two main factors and two subfactors which are deep and surface learning, and motive and strategy respectively.

The MAI consists of 52 items with the two main factors of metacognitive knowledge and metacognitive regulation. Metacognitive knowledge breaks down into three subfactors of declarative, procedural, and conditional knowledge. Metacognitive regulation comprises five theoretical components: planning, information management, monitoring, debugging, and evaluation.

TABLE 1
ALPHA SCORES FOR R-SPQ-2F AND MAI SUBSCALES IN FULL SAMPLE

R-SPQ-2F Subscale	Alpha value	MAI subscales	Alpha value
Overall Deep	.779	Metacognitive regulation	.768
Overall Surface	.786	Metacognitive knowledge	.600

Finally, data on student performance is measured by the final grade percentage sourced from official University records. The overall grade is a cumulative grade of all the assessments taken throughout the Psychology course and therefore can be a proxy for the effects on learning outcomes. A small number of students (n=37) subsequently dropped out in their first semester meaning their grade data was unavailable.

Analysis

Students who completed the measure only at one point (n=944) were analysed using a MANOVA test to examine the effects of each scale on student grade (deep learning, surface learning, metacognitive knowledge, metacognitive regulation). ANOVA statistical analysis was also used to examine the general differences between year groups. Finally, across–lagged model then explored the differences within the individual students who completed the measures at both time points (n=385). The data was analysed using SPSS Statistics version 24 and AMOS version 24.

RESULTS

To explore the between and within changes in student learning a series of analyses were conducted. The first analysis used the data from students who responded at a single time point only Table 1 presents the descriptive statistics and results of the Spearman's Correlation test between the theoretical components of learning approaches (deep and surface) and metacognition knowledge and regulation.

TABLE 2
SPEARMAN'S CORRELATION FOR LEARNING VARIABLES (N = 944)

	Mean (± SD)	Deep Learning	Surface Learning	Metacognitive Knowledge	Metacognitive Regulation
Deep Learning	29.01 (± 6.64)	-			
Surface Learning	23.29 (± 6.71)	- .433*	-		
Metacognitive Knowledge	12.25 (± 2.48)	.240*	- .211*	-	
Metacognitive Regulation	24.84 (± 5.17)	.360*	.257*	.436*	-

*p < .001

Differences Across Year of Study

A MANOVA statistical analysis explored the first hypothesis (H1) regarding the differences between the years of study and the four learning variables (two learning approaches and two metacognition components). The data for surface learning and both metacognitive components were not normally distributed and so were log transformed prior to the analysis (see Appendix).

The MANOVA showed a significant effect of the year of study [Pillai's trace = .304, F (2, 710) = 31.73, $p < .001$, $\eta^2 = .152$]. Significant differences between year group and metacognitive regulation, deep learning approaches and surface learning approaches were found. No significant differences were found between the year group and metacognitive knowledge. Significant findings and post hoc tests are reported below.

Metacognitive Regulation and Year

A significant effect of year and metacognitive regulation was found, F (2, 712) = 5.21, p = .006, η^2 =0. 14, Specifically, there was a significant difference between (i) the baseline initial measurement (24.50 ± 4.95) and year three responses (26.05 ± 4.98) (Dunnett T3, p =.003), and (ii) between years two (24.44 ± 5.67) and year three responses (Dunnett T3, p = .022).

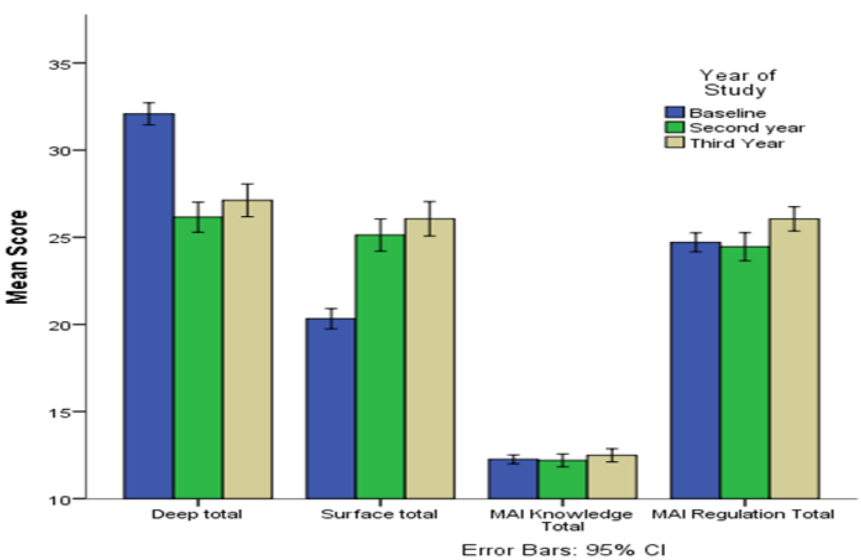
Deep Learning and Year

There were also significant differences between deep learning exhibited by students in different years F (2, 712) = 70.40, $p < .001$, η^2 =. 165, Deep learning scores decreased significantly (Bonferroni $p <.001$) from baseline, (31.86 ± 5.75) to year two (26.23 ± 6.09) and year three (27.05 ± 6.68). However, there was no significant difference between scores in the second and third years (p = .354).

Surface Learning and Year

A similar pattern of results was found with surface learning scores, F (2, 712) = 65.52, $p < .001$, η^2 = .154. Scores at baseline (20.59 ± 5.43) were significantly (Bonferroni $P < .001$) lower than scores at year two (25.14 ± 6.57) and year three (25.94 ± 7.13). Again, there was no significant difference between scores in year two and year three (p = .548). Figure 2 illustrates the mean scores for the four variables measured in different years of study.

FIGURE 2
THE MEAN SCORES WITH ERROR BARS FOR THE FOUR VARIABLES (LEARNING APPROACHES AND METACOGNITION COMPONENTS) COLLECTED IN SEMESTER ONE 2016-2017 ACADEMIC YEAR



Differences in Assessment

The potential differences between the three years of studies (groups) based on student performance over time were analyzed to test the second hypothesis (H2). A MANOVA statistical analysis based on grade boundaries showed a significant effect of grade [Pillai's trace = .050, $F(4, 708) = 2.23$, $p = .003$, $\eta^2 = .012$]. No significant differences were found for metacognitive factors of knowledge ($p=.611$) or metacognitive regulation ($p = .698$).

Significant differences between grade boundaries with both deep [$F(4, 708) = 5.18$, $p < .001$, $\eta^2 = .028$] and surface learning [(F (4,563)6.07, P=.034 $\eta^2 = .011$] were found. In the case of deep learning, the only significant differences identified were between students who failed (33.92 ± 8.03) and those who passed with (i) a third grade (27.59 ± 6.74), p = .013; (ii) a 2:2 grade (28.61 ± 5.53), p= .004, (iii) a 2: 1 grade (28.38 ± 6.90), p=.047 or (iv) a first grade (29.80 ± 6.60), p = .038. Conversely, in the case of surface learning, results were only significantly different at the higher grade levels between those who received grades 2:2 (24.03 ± 6.34) and first (22.31 ± 6.65), p = .038 or a 2:1 (23.89 ± 6.93) and a first, p = .002. A further analysis of the overall effect of the year was considered. However, the model was not significant (p = .164).

Clustering of Variables

Following the literature suggestions regarding the contradictory and non-significant findings on different student grade clusters, clusters were created by dividing student scores into high and low scores, using a median split. Four group clusters were created: those that were high/low on both measures and those that were high on one measure and low on the other. These were used to further explore H2.

A one-way ANOVA showed there was no significant difference between the metacognitive clusters and grade (at baseline: p = .128, at second year: p = .726 or third year: p = .086). A further one-way ANOVA examining the effect of the learning approaches and cluster group showed no significant differences between the second (p = .216) and third year (p = .910) clusters. There was, however, a significant effect at the baseline cluster ($F(3, 466) = 7.77$, $p<.001$) for the learning approach. Specifically, high-scoring students on both high and deep surface learning approaches (57.33 ± 18.93) had significantly lower scores than (i) students with high surface and low deep scores, (65.15 ± 13.39) p <.001, or (ii) those with high deep and low surface scores, (63.62 ± 10.64) p = .017, and (iii) students whom for both scales showed low scores, (63.09 ± 18.05) p = .028.

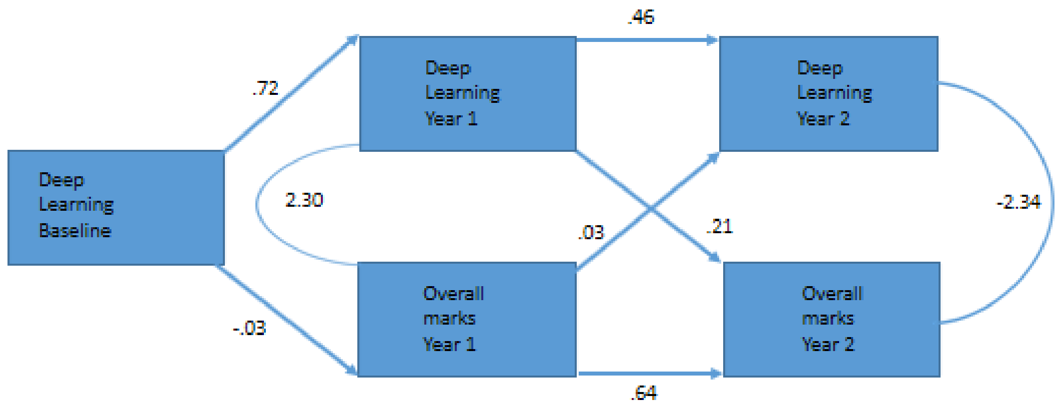
The grades of students who completed the study more than once (63.59 ± 8.08) were significantly higher than those who completed the questionnaire only on one occasion (62.17 ± 13.12). Equal variances not assumed $t(869.54) = -2.164$, $p = .031$. These students represented the more conscientious type, however, further paired samples t-test's show that their marks do not vary over time (year 1 to year 2: p = .691 and year 2 to year 3: p = .510).

Cross-Lagged Models

The next step looked at the longitudinal effects of each of the learning predictors on the student's final grade record using a series of cross-lagged models to test the third and fourth hypotheses These models were used due to their ability to estimate autoregressive effects and examine the directionality of the relationships between the two learning concepts (Little 2013; Newsom, 2015). Full Maximum Likelihood (FML; see Enders 2001) was used to handle missing data. After establishing measurement invariance, bidirectional cross-lagged panels were used to investigate the reciprocal relationship between each of the variables in student grades.

Our results indicated that the cross–lagged model displayed a poor to adequate fit, $\chi^2 = 11.30$, $p = .004$, NFI = .944, CFI = .950, RMSEA = .146. Apart from the initial deep learning model, no other variables showed an association with grades over time. Specifically, the levels of deep learning at the end of the first year significantly contributed to the overall grade for year one independently of previous learning ($\beta = .21$, SE = .09, p = .013) (see Figure 3).

FIGURE 3
CROSS-LAGGED PATH MODEL FOR DEEP LEARNING BETWEEN BASELINE AND YEAR ONE AND TWO



Unfortunately, when analyzing the longitudinal data, the groups were unevenly weighted, meaning that it was not possible to conduct inferential testing on this data. Descriptively, 56.9% of students presented a change in their learning between the baseline measure and year two, in either their metacognitive knowledge or regulation and/or their approach to learning. Similarly, 53.6% of students presented a change in these scores between years two and three. These changes in one variable (student learning strategies and metacognition) did not correlate with changes in the other ($p = .299$, years 2/3 $p = .216$). Students with high initial scores in one area (e.g., metacognitive knowledge) tended to change scores to a lesser extent than those with low initial scores in the same area.

DISCUSSION

The aim of this study was to examine how the SAL and metacognition of Psychology students change over time. Based on students' responses to the self-reported questionnaire and their grade records, students' metacognitive regulation increases over time, but metacognitive knowledge is not affected over the years. In the case of SAL, results show distinct changes from the initial baseline scores gathered at the start of student studies to the second semester of year 1. In the case of deep learning, there is a decrease over time whilst surface learning has a slight initial increase between the first and the second year, but it then remains relatively stable longitudinally. Both changes indicated mostly a weak or non-significant association with the final grade.

When examining the between subjects' data, no differences were found between students' levels of metacognitive knowledge and year group. However, metacognitive regulation abilities showed significant differences between years, increasing steadily from year 1 to year 3, with the steepest increase seen between years two and three. This finding aligns with Young and Fry (2008) who found changes across the metacognitive knowledge but not across metacognitive regulation within undergraduate and postgraduate students.

Both the deep and surface learning approaches changed throughout student studies. Surface learning increased considerably in the first year of studies and then remained steady across years two and three. Conversely, levels of deep learning decreased from the baseline to the second year of study but remained unchanged between the second and third year. Equally, as identified by the correlations between metacognition and learning approaches (Table 2) there are the interconnectedness of both deep and surface approaches. However, a lack of consistent correlation is identified when examining changes over time. Although these concepts may be linked together, they do may not develop at similar rates in students.

Assessment type provides one potential explanation for these changes. In the programme under investigation, first-year students were predominantly assessed using multiple-choice examinations, which typically support students adopting a surface learning approach (Elliot et al., 1999). By initially presenting students with assessment types that encourage surface learning, students will likely continue to use this approach throughout their studies. This is likely due to the reduced time and effort needed in this approach, which by the student is still perceived to be sufficient in achieving a good academic outcome. Levels of deep learning increased (albeit non-significantly) in students within their third year, a finding which could be related to increased subject mastery and/or increased interest as the curriculum becomes malleable to the student's own interest areas through optional modules and/or the 3rd year dissertation (research project).

The large differences between student learning strategies at baseline and other time points could be explained by two interpretations. Firstly, this difference could be based on prior experiences, and limited exposure; students have to a variety of engaging teaching methods and learning approaches within their educational experiences prior to starting university (Wingate, 2007). This means that if students have not had access to a wide range of effective teaching methods and used to employ various learning approaches previously, they may struggle to adopt a new approach to adapt themselves to the demands of the new teaching methods, enhancing their learning experience. For instance, if a student had a teacher whose teaching primarily relied on lectures and memorization-based assessments, they may not be as prepared to adopt a deep learning approach or they may need more effort and time to excel in a class that requires critical thinking and problem-solving skills. On the other hand, students who had opportunities to engage in more hands-on and interactive learning experiences may be better equipped to adopt deep learning and to tackle academic challenges which are based on the higher order skills (i.e., apply and synthesize knowledge, and critical thinking; Phan, 2011). Equally, overly ambitious expectations by the students regarding the learning approaches they thought they would use at university could also explain our findings. Based on the previous literature, higher education requires independent study, often forcing initial plans to approach learning with deeper strategies to ones with more realistic estimates once students gain university experience and familiarise themselves with course workloads (Diseth, 2007; Murray-Harvey & Keeves, 1994). The findings of this study indicated that it was likely that the workload demands over the years may have resulted in changes to SALs. It seems that work demands increase students may engage in "satisficing" approaches (a decision-making strategy in which the individual aims for an adequate over optimal result) by investing the bare minimum time and effort needed for a task's completion (Biggs, 1993). It is possible that students who followed a surface learning to mainly factual recall information rather than to spend effort and time for deeper learning experience as they. In general, it is easier to induce a surface approach to learning than to encourage a deep approach (Marton & Säljö, 1976; Jabarullah, & Hussain, 2019).

Regarding SALs and student grade results, it seems that failing students within the sample were perhaps overconfident in their levels of deep learning rating these higher than any other group. A potential explanation regarding this finding could be that these students may overestimate their effort wrongly, thinking they follow a deep learning approach. A potential training on how they study and reflect on knowledge to develop high order skills may assist these students (e.g., Filius et al., 2019, who used audio-based peer feedback to develop students deep learning strategies). The data also indicated that as students' grades improved over the years, they tend to rely less on superficial methods of learning. This implies that while a basic level of surface learning can be helpful in achieving a passing grade, it may not be enough to achieve higher grades. This links to Biggs' (2003) suggestion that students may be effective strategies but in an inconsistent or poorly conceptualized manner within their learning approaches, possibly because they are not equipped to know how to use such techniques effectively when first entering higher education (Wingate, 2007). The lack of change in metacognitive abilities is likely due to the high standards placed on students for entry into the course. Those severely lacking in metacognitive knowledge or regulation are unlikely to reach tertiary education (Luwel et al., 2003).

Students who completed the questionnaire more than one-time point (had significantly higher grades than those who only took it once. This is perhaps not surprising since those with better engagement levels tend to be more willing to engage in such self-report inventories (Porter, et al., 2004; Neilson, et., 1978). This raises the question of how representative this sample is to the wider student cohort. This finding coupled with the evidenced changes in metacognitive regulation, suggests that the changes found in this study and that of Young and Fry (2008) may be driven by more able students in the sample. These students could potentially continue within higher education whilst those lacking in good metacognition and effective deep study habits are less likely to continue, terminating their studies at the undergraduate degree level.

Viewing the sample as a whole cohort, students' directions of learning approach did not change as much as it was, and it has been found that effect sizes were small. The findings of this study overlook the possibility of significant changes within the subgroup level. It is possible that different groups exist within the population as suggested by Asikainen and Gijbels (2017). Indeed, when examining the between-subjects (cluster) data, students who scored highly for both deep and surface learning approaches at the initial baseline exhibited grades considerably lower than those in other clusters. One potential explanation for this finding could be that these students could be taking a sporadic study approach, using a variety of diverse approaches, hoping to find out which of the two worked better each time or because the curriculum structure that the fixed modules they did not have interest in all the modules. However, by the time these students reached the end of their first year, they had experience with the course and assessment demands. Their approaches appeared to be much more stable, with most leaning marginally towards deeper learning supported.

Limitations

This study did carry with it a range of limitations. Unfortunately, the longitudinal sample was too small to effectively test for variance within student clusters due to the high attrition rate. Attrition might in part have been due to the long 80-item questionnaire. Students who completed the study at more than one point tended to perform better and more engaged than the other students. As such, the lack of change seen in these students may be because of the fact they were already using successful metacognitive skills and approaches to their learning. A further explanation for the lack of this change is suggested by Richardson (2011) who noted that students tend to give similar answers across time based on their perceptions of learning. Ironically, poor metacognition means that students are more likely to report a lack of change in their views, perceptions or, even if their study habits have changed.

Another limitation was the broadness of the measures used and sample selection biases. As Yonker (2011) noted students tend to vary their learning approach according to the task. By asking at the overall course level students might have responded differently than if asked at a more granular level, such as a module or even task level. Examining these factors at a course level allowed students to generalise their experience. However, due to immediacy effects contextual factors they would have mediated their responses on the questionnaire. For example, within the degree programme, students in their third year could pick from a choice of modules, whereas those in their first and second years could not thus driving students to have different interpretations of current tasks and assessment types, creating answer variation. Indeed, as Laurillard (1997) suggested approaches to learning might be not stable characteristics but rather determined solely by student perceptions of the need for the current task. Several factors, such as perception of assessment, current workload, topic interest, and personality traits and states (e.g., mental health well-being) might also affect student responses (Bostani et al., 2014). For the student sample, the curriculum included fixed modules for the first two years, while the types of final exams were mainly multiple-answer questions. Essay-type questions, for which students should exhibit more advanced high-order skills and deep learning (i.e., critical evaluation and knowledge synthesis) (Scouller, 1998), mainly support the coursework and its weight against the final grade was less than the final exams.

A third limitation is related to the self-reporting measures used. Studies examining SAL have shown that reported answers might differ distinctly from actual student behaviours (Dinsmore et al., 2008; Artelt, 2000). Students may tend to report strategies they prefer to use rather than those they do use (Samuelstuen & Bråten, 2007). Thus, it is possible that students reported their perceptions or intentions rather than their actual study habits, contributing to the lack of connection between student approaches and grades. As Groves (2005) pointed out these measures rely on student self-reporting and as such, any shift from deep to surface learning may be more closely related to a change in perceptions rather than an actual change in one's learning approach. Richardson (2004) further suggested that changes seen in the longitudinal use of self-report measures could simply be because students reconstructed their autobiographical memories of their study habits to fit implicit theories about personal change. In the case of the baseline measurements, it is likely that some students overestimated their levels of metacognitive regulation and deep learning based on the course's expectations rather than their own study habits. Just because students perceived themselves as deep learners did not mean they necessarily were (Choy et al., 2012). Students moving from A-level study to a university degree level often adopt a deep learning strategy in the first few weeks of the course but might fail to sustain it as the workload on the course increases gradually over the years of studies (Lawless & Richardson, 2002). This trend might also be reflected in the findings of this study.

Implications

This investigation's main implication suggests that teachers should promote awareness and, thus, better learning behaviours simply by informing students about effective problem-solving strategies and discussing cognitive and motivational thinking characteristics (Mokhtari & Reichard, 2002) by offering relevant training to students. Along with the wider literature recommendations, the findings of this study support the idea that teachers should aim to introduce students to new ideas that would prove helpful in supporting learning processes (Trowler & Bamber, 2005). Part of the challenge for teachers is how to encourage students to develop deeper approaches (Tomanek & Montplaisir, 2004). Ultimately, students' choice of learning approach will depend on a multitude of factors. These may result from a complex interaction between metacognitive ability, previous effectiveness of strategies used, teaching context motivation levels, and assessment type (Entwistle & McCune, 2004). The effect of each of these factors will also vary from task to task, meaning a clear pattern of SALs may be difficult to identify (Fincher et al., 2006). Nonetheless, by developing a clear understanding of how students approach their learning, appropriate solutions can be recommended to students regarding their learning process, improving student outcomes (Sharma, 1997).

CONCLUSION

This study aimed to contribute to the interesting topic of students' learning patterns in Higher Education, recognizing the literature gap (Asikainen, & Gijbels, 2017). The study's findings suggest a complex yet clear relationship between student learning approaches and their final grade outcomes. Students will lean towards more surface learning as their (perceived) workload increases, and assessments become more challenging. These changes vary in less abled students who show much lower levels of change than higher performing students, suggesting the existence of distinct clusters producing differing study behaviors and outcomes. By supporting the development of strong metacognitive abilities in students, teachers can facilitate student usage of deep learning strategies, which there is a small but noticeable effect on academic achievements. Taking such action not only improves the success of a department/university but also facilitates continued student success within their studies and unlocks higher/wider opportunities upon their degree completion.

Future studies would benefit from a longer period of longitudinal measurement including how students are approaching their learning and the quality of it (Chan, 2010), as well as following students through until the end of their study. Taking such an approach would enable educational researchers to more accurately track when learning approach/metacognition changes occur. Studies should also take place with students showcasing a wider range of abilities. The current study mostly found responses from students at the upper end of the degree profile (2:1 and above), therefore the learning patterns seen may not accurately reflect those at the lower end who are arguably most in need of intervention to help support their learning.

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