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Supporting thinking about thinking: examining the metacognition theory-practice gap in higher education

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Abstract

Metacognition is the knowledge and regulation of one's cognition and has been associated with academic performance across all levels of education, including higher education (HE). Previously, a gap has been reported between extensive metacognition research and elaboration of theory versus minimal inclusion of metacognition in teaching practice in primary and secondary education. The present study investigated whether this theory-practice gap extends to HE. Furthermore, we took a novel approach to evaluating academics' broad and implicit inclusion of metacognitive supportive practices (MSPs) in their teaching practice. A questionnaire and semi-structured interviews were used to evaluate awareness of metacognition and inclusion of 16 MSPs in undergraduate teaching among 72 academics in scientific disciplines at a UK research-intensive university. We found that a minority of academics (27/72, 37.5%) were familiar with metacognition and, of those who were, they typically emphasised knowledge of cognition, rather than regulation of cognition. Nonetheless, all respondents incorporated at least two MSPs in their teaching, although typically in a limited fashion, emphasising knowledge and understanding of discipline content rather than cognitive regulation. Compared to academics without a teaching qualification, respondents holding or working towards a teaching qualification used significantly more MSPs, earlier in their career, and used significantly more MSPs aligned with regulation of cognition. This study demonstrates that the metacognition theory-practice gap extends to HE and highlights the scope for staff development programmes to better support students' metacognitive development relevant for their studies and post-graduation careers.

Keywords Metacognition · Metacognitive supportive practices · Teaching strategies · Teaching qualification · Higher education

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Introduction

In higher education (HE), the majority of learning takes place outside of formal teaching sessions (Nordell, 2009), and there is an emphasis on independent learning (Hockings et al., 2018). Consequently, HE students must take responsibility for their learning, not only in terms of time and resource management, but also in terms of how they learn. Students who enter HE from the highly supportive school environment often struggle with assuming this responsibility and face challenges when developing new ways of learning and finding suitable study methods (Nuade et al., 2016; Christie et al., 2008). There are many facets to learning, including the actual cognitive processes of learning, plus planning, monitoring progress, evaluating comprehension, using appropriate studying strategies and reflecting on the efficacy of learning approaches. Awareness and monitoring of these cognitive and learning processes is called metacognition (Flavell, 1976).

Metacognition is colloquially defined as 'thinking about one's own thinking' (Georghiades, 2004, p. 365) and more formally defined as 'the knowledge of cognition and strategies to regulate it' (Muijs & Bokhove, 2020, p. 7). A metacognitive student is one who knows how to learn because they appreciate what they know, what they must do, and the merits of different approaches to acquiring and understanding new knowledge (Wilson & Bai, 2010). Studies have reported small positive relationships between metacognitive ability and academic performance in primary, secondary and tertiary education (Swanson, 1990; Adey & Shayer, 1993; Young & Fry, 2008).

In a review of metacognition research, Zohar and Barzilai (2013) found a dearth of research on educators' knowledge about teaching metacognition: of 178 studies, 27 (15.2%) focused on teachers, and, of these, only five investigated teachers' pedagogical knowledge in the context of teaching metacognition, and none were situated in HE. Where educators' knowledge of metacognition has been investigated, studies found that science teachers in primary and secondary education are largely unaware of metacognition, despite the wealth of published research studies (Ben-David & Orion, 2013; Zohar, 2006; Wilson & Bai, 2010). Consequently, Zohar and Barzilai (2013) concurred with Georghiades who, nearly a decade earlier, wrote:

> The current state of the literature on metacognition has already given signs of a theory-practice gap emerging, comprising extensive academic elaboration on the mechanisms of metacognitive thinking and rare attempts to bring this inside ordinary classrooms. (Georghiades, 2004, p. 379)

Given the scarcity of research examining metacognition in teaching practice, the primary aim of this study was to investigate whether the metacognition theory-practice gap extended to the teaching practice of academics in HE.

Theoretical background: defining metacognition

Literature reviews have identified variable and inconsistent definitions of metacognition for more than four decades (Muijs & Bokhove, 2020). The term 'metacognition' is ascribed to Flavell who originally defined it as 'one's knowledge concerning one's own cognitive processes' and 'the active monitoring and consequent regulation and orchestration of [cognitive] processes' (Flavell, 1976, p. 232).

Flavell described metacognitive knowledge as ‘knowledge or beliefs about what factors or variables act and interact in what ways to affect the course and outcome of cognitive enterprises’ (Flavell, 1979, p. 907). Flavell further elaborated on three categories of factors within metacognitive knowledge: person, task and strategy (Flavell, 1979). Later, Jacobs and Paris (1987) described three different categories of metacognitive knowledge: declarative, procedural and conditional knowledge. Declarative knowledge describes what we know about our own cognition and the cognitive strategies available to us; procedural knowledge explains how to put those cognitive strategies into practice; and conditional knowledge is knowing when and why to use a particular strategy (Pintrich et al., 2000).

Flavell’s metacognitive regulation, alternatively called metacognitive skills by some researchers (e.g. Efklides, 2011; Veenman et al., 2006), describes the control of cognition in relation to the objective of an activity (note the assumption that individuals construct goals for their cognitive endeavours). Regulation can occur before, during and after the activity and is typically labelled as planning, monitoring and evaluation (Schraw & Moshman, 1995). Metacognitive regulation is sometimes described as a skillset (e.g. Jiang et al., 2016) because it comprises active processes rather than knowledge possession.

Flavell later supplemented the cognition-focused definitions of metacognition with ‘metacognitive experience’, which is the affective experience associated with a cognitive endeavour (Flavell, 1979). This affective experience creates overlap between metacognition and self-regulation, which is the setting of goals and ensuring those goals are attained. When self-regulation occurs in the context of learning, it comprises cognition, metacognition, motivation and affect (Boekaerts, 1996; Efklides, 2011). The conflation of metacognition, self-regulation and self-regulated learning (SRL) motivated Dinsmore and colleagues (Dinsmore et al., 2008) to review the theoretical and empirical boundaries between the constructs: they found that the keywords ‘monitor’, ‘control’ and ‘regulate’ were frequently used in relation to all three constructs; ‘motivation’ and ‘behaviour’ were rarely used in the context of metacognition but were often used in self-regulation and SRL; and ‘knowledge’ was more commonly used in the relation to metacognition than either self-regulation or SRL. Although monitoring and regulation of cognition are undoubtedly effortful (Efklides, 2011) and interact with students’ motivation and affect, our study defines metacognition as the ‘knowledge and control of one’s own cognitive system’ (Brown, 1987, p.66) and, like many studies before it, focuses on knowledge and regulation of cognition at the expense of investigating metacognitive experiences (Georghiades, 2004).

Empirical background: metacognition in education and teaching practice

Metacognition develops during childhood (Flavell et al., 1970) and continues to increase with age until at least early adulthood (O’Neil and Abedi, 1996), although there is significant variation in metacognitive ability between individuals within a given age group (Georghiades, 2004). It has been suggested that academically able students can construct elements of metacognition, whereas less academic students cannot (Ben-David & Orion, 2013). Consequently, initiatives have been implemented in schools to develop metacognitive ability, especially among academically weaker students. These initiatives include Cognitive Acceleration through Science Education (CASE), ReflectED and Thinking, Doing, Talking Science which, together, have been shown to increase students’ cognitive development and academic achievement in Science, Maths and English in primary and secondary education (Adey & Shayer, 1993; McCormack et al, 2014; Motteram et al, 2016; Hanley et al., 2015).

Metacognitive research within education can be divided into two broad categories: descriptive studies of learner variables which advance understanding of metacognition and studies which evaluate interventions designed to enhance students' metacognition. In both study types, a common dependent variable is academic performance, measured as either a score on a study performance task, assessment at the end of a teaching block or overall academic performance, such as Grade Point Average (GPA).

Descriptive studies consistently identify statistically significant, although small, correlations between metacognition and academic performance, ranging between r = .15 and r =.20 (Vrugt & Oort, 2008; Cooper & Sandi-Urena, 2009; Muis et al., 2011). A meta-analysis of the influence of demographic and psychosocial factors on undergraduate academic performance also revealed a small and significant relationship between metacognition and GPA (r+ = .18, 95% CI [.10, .26], where r+ represents average-weighted correlations in the meta-analysis; Richardson, et al., 2012). The size of this relationship was comparable to those seen with other predictors of academic outcomes, such as socioeconomic background (r+ = .11, 95% CI [.08, .15]) and academic intrinsic motivation (r+ = .17, 95% CI [.12, .23]), both of which have been extensively researched in HE (Rodríguez-Hernández et al., 2020; Özen, 2017). Clearly, metacognition is not the only factor that contributes to academic success; however, it is of interest because intervention studies have demonstrated that students' metacognitive ability can be enhanced.

Supporting students' metacognitive development in HE

Many studies have investigated the impact of a range of interventions on students' metacognition and academic outcomes in HE. These studies are often observational, and a few use experimental or quasi-experimental designs with controls and pre- and post-measures (Zohar & Barzilai, 2013). While acknowledging the limitations caused by variations in scientific rigour and the small effect sizes typically reported, these studies have described gains in students' metacognition associated with teaching strategies; we call these teaching strategies 'metacognitive supportive practices' (MSPs). We conducted literature searches on 'metacognition' in 'higher education' since the year 2000 and drew on original articles, reviews and opinion articles to capture a broad repertoire of teaching practices which support students' thinking in and about their undergraduate studies. After excluding strategies which were either not implementable in individual lectures (for example, flipped learning, problem-based curricula and IT-dependent interventions) or which occurred outside of teaching contexts (for example, coaching), 16 MSPs were identified and then separated into five categories through a process akin to thematic analysis (Table 1; Braun and Clarke, 2006).

The first category of MSPs centred on students declaring their knowledge and understanding of the discipline. Identifying prior knowledge is advocated by articles promoting strategies to support students' metacognition (for example, Tanner, 2012), and a randomised trial with medical students suggested that it enhanced subsequent learning (De Grave et al, 2001). Asking first-year physics students to articulate their understanding, especially during problem-solving, was found to increase their awareness of how they are learning and the value of understanding concepts (Mills et al, 1999). Also in this category, Dhieb-Henia (2003) described a mixed-methods quasi-experimental study of undergraduate biology students who were taught how to identify key information when reading

Table 1 Metacognitive supportive practices (MSPs), grouped according to their theoretical alignment with metacognition constructs

Metacognitive supportive practices
Declarative knowledge and understanding of the discipline
Identifying prior knowledge
Separating key issues from less important information
Articulation of understanding
Analysis of discipline content
Constructing concept maps or mind maps
Experimental scenarios which invite students to predict, observe and explain results
Group work where students explain their thinking/rationale to each other
ConcepTests comprising posing a question, student polling, discussion, and re-polling
Metacognitive monitoring
Checklists or prompts
Indicate confidence in answers
Peer assessment
Self-assessment
'Think-alouds' where students verbalise cognitions
'Think-alouds' where staff verbalise cognitions
Metacognitive evaluation
Evaluate alternative approaches
Reflection on studying
Strategic knowledge
Explicitly categorising thinking, for example, using Bloom's taxonomy

scientific papers; students in the experimental group increased their procedural knowledge relative to those in the control group.

The second category of discipline-focused MSPs centred on analysis of discipline content, often in a social context. The predict-observe-explain model of scientific investigation (White & Gunstone, 1992) was shown to increase students' academic performance in a quasi-experimental study in college-level chemistry (Hilario, 2015). Also in a chemistry laboratory course, Sandi-Urena et al (2011) demonstrated that group collaboration subsequently enabled students to solve more complex problems, although the effect size was small (Cohen's $d = 0.2$). McConnell et al (2006) developed a bank of over 300 ConcepTests in geosciences, where students were polled on a question, then engaged in peer discussion and were repolled. Although not evaluated in rigorous experimental conditions, they reported several positive effects associated with ConceptTest implementation, including increased student learning. Finally, constructing concept maps (graphical representations of a topic) has been associated with improved academic performance by 20 percentage points in a quasi-experimental crossover study in engineering (Martínez et al, 2013).

Two MSP categories were concerned with metacognitive regulation: monitoring and evaluation, respectively. To support students' monitoring skills, Trujillo et al (2012) used prompts in a college-level molecular biology class which challenged students' assumptions and their implications; after the intervention, students made fewer errors in their reasoning. Similarly, Chew et al (2016) used a mnemonic to support medical students' clinical decision-making; in their quasi-experimental study, students in the experimental group achieved significantly higher grades than those in the control group. 'Knowledge surveys' enable students to monitor their confidence in answering test questions; although such surveys reveal deficits in students' judgements (Bell & Volckmann, 2011) consistent with the Dunning-Kruger effect (Kruger & Dunning, 1999), these deficits can be overcome by specific instruction in the dangers of over-confidence (Roelle et al, 2017). Assessment against mark criteria, either of students' own work or their peers' work, enables students to develop awareness of their competencies (Borton & Anderson, 2018) and increase the quality of their work (Navarro et al, 2022). Finally, think aloud exercises, conducted by staff or students, enable others to witness a person's thinking processes. Such activities can reveal novice students' procedural deficiencies while conducting a task, compared to experienced students (Holmstrup et al, 2015).

The second category of MSPs concerned with metacognitive regulation centred on evaluation. Colthorpe et al (2018) used 'meta-learning questions' to encourage biomedical sciences students to evaluate their study and assessment strategies and goal achievement. Their quasi-experimental study reported a statistically significant increase in students' test scores by three percentage points and changes in study strategies, most commonly among the lower performing students. Similarly, Case et al (2001) adopted a questioning strategy in their teaching of undergraduate chemical engineering; qualitative assessment of students' journal entries suggested that the practice resulted in students becoming more aware of suitable study strategies and increased monitoring of their learning. In addition to being a research tool, reflective journal entries can also enable students to surface their metacognitive thoughts and become aware of their learning (Kurt & Kurt, 2017).

The final MSP utilised strategic knowledge of thinking: categorising problems and exam questions into Bloom's Taxonomy (Bloom, 1956) using tools such as Bloom's-based Learning Activities for Students. Crowe and colleagues (Crowe et al., 2008) suggested that this tool increased college students' metacognitive development and study skills.

Previously, subsets of these MSPs have been collated in reviews (Zohar & Barzilai, 2013; Tanner, 2012; Medina et al, 2017). However, we are not aware of any study at any level of education that has evaluated the broad inclusion of such metacognition-associated strategies in teaching practices.

The present study

The literature outlined above describes HE as an environment where undergraduate students are expected to take responsibility for their learning. In this environment, it is advantageous for students to be metacognitive, as evidenced by the small, positive associations between academic success and metacognitive ability, and results from intervention studies indicating that metacognitive ability can be improved through instruction embedded in HE teaching. Metacognition research carried out in primary and secondary schools suggests that educators in these settings are generally unaware of metacognition, although there is a paucity of studies in this area (Zohar & Barzilai, 2013). The present study was the first to investigate this theory-practice gap in HE. Specifically, the research questions were as follows:

1. To what extent are HE academics aware of metacognition?
2. To what extent do HE academics include metacognition in their teaching practice?
3. What reasons do HE academics give for implicitly supporting metacognition in their teaching practice?

Methods

Participants

The study was conducted at a UK research-intensive university. Invitations to participate were sent to 136 academics, and 77 responses were received (56.7% response rate). Seventy-two respondents completed all sections; data were analysed from these respondents only (Table 2).

Prior to data collection, ethical approval was sought, and granted, from the appropriate review committees at both authors' institutions. Informed consent was obtained from participants prior to both phases of the study.

Online questionnaire

A novel online questionnaire was developed to measure implicit inclusion of metacognition in teaching practice. Participants indicated how frequently they used each of the 16 MSPs (Table 1) in their undergraduate teaching ('never', 'rarely', 'sometimes' or 'often') or if they were unfamiliar with the MSP.

Awareness of metacognition was then assessed using the question 'Have you heard of "metacognition"?' with pre-defined responses ('yes', 'vaguely' or 'no'). Participants who

Table 2 Profiles of 72 academics who completed the online questionnaire and the subset of 5 respondents who were interviewed

	Number of questionnaire respondents (%)	Number of interview participants
Discipline taught		
Biochemistry	7 (9.7)	
Biological sciences	20 (27.8)	1
Biomedical sciences	21 (29.2)	2
Chemistry	10 (13.9)	1
Medicine	4 (5.6)	
Psychology	7 (9.7)	1
Other	3 (4.2)	
Years of teaching experience		
Less than 5	21 (29.2)	2
5–9	17 (23.6)	2
10–19	18 (25.0)	
20 or more	15 (20.8)	1
Not specified	1 (1.4)	
Teaching qualification		
Qualification awarded or in progress	48 (66.6)	4
No qualifications declared	24 (33.3)	1
Gender		
Male	46 (63.9)	3
Female	26 (36.1)	2

selected either 'yes' or 'vaguely' were invited to outline their understanding of metacognition in a free text response.

The online questionnaire was implemented using Qualtrics' Research Core survey tools (Qualtrics, Provo, UT). The questionnaire commenced with a brief outline of the study and sought participants' consent; it concluded with participants indicating whether they wished to participate in the follow-up interview and/or prize draw, before being invited to provide any free text comments. Respondents typically completed the questionnaire in less than 11 min.

Interviews

Half of the questionnaire respondents (36/72) indicated willingness to participate in a follow-up interview. Five were purposely selected to represent the spectrum of respondents; all five agreed to be interviewed (Table 2). Semi-structured interviews were conducted to gain deeper insight into academics' attitudes towards developing students' metacognition and thinking skills. The interview schedule was informed by Zohar (2006) who investigated teachers' development of meta-strategic knowledge. Interviews lasted between 40 and 55 min and were audio recorded; recordings were later transcribed and checked for accuracy.

Analysis

For each respondent, a 'MSP score' was calculated which captured both the number and frequency of MSPs used in teaching practice; this was calculated as the sum of the frequency of use, from zero ('never') to three ('often') across the 16 techniques. 'MSP type' scores evaluated use of the different types of MSPs (for example, 'declarative knowledge and understanding of the discipline' or 'metacognitive monitoring', Table 1). For each respondent, five 'MSP type' scores were calculated as the sum of the frequency of use, from zero ('never') to three ('often'), of MSPs within each type and then divided by the number of MSPs within each type. Quantitative data was analysed in SPSS (version 25).

Interview transcripts were analysed by thematic analysis (Braun & Clarke, 2006). Data-driven codes were developed and arranged into themes, and then transcripts were coded using NVivo 12 (QSR International Pty Ltd) to identify features related to the research questions. Coded items were reviewed in relation to the quantitative findings, and extracts were identified which either expanded upon or gave insight into the quantitative data.

Results

RQ1: To what extent are HE academics aware of metacognition?

A minority of questionnaire respondents (27/72, 37.5%) reported that they had heard of metacognition and, of these, the majority indicated that they were only vaguely aware of the construct (16/27, 59.3%). Respondents who taught psychology were significantly more likely to have heard of metacognition compared to academics teaching other disciplines ($p = .002$, two-tailed Fisher's exact test, Cramer's $V = 0.519$); this corresponds to a large effect size. Additionally, females were more likely to have heard of metacognition than male respondents, although with a small effect size ($\chi^2(1) = 4.639$, p

= .031, φ = .25). This may be because there were proportionally more females among the psychology respondents: 71% of psychology respondents were female, compared to other disciplines where between 20 and 50% of respondents were female. Awareness of metacognition did not significantly differ with either duration of teaching experience or possession of a teaching qualification.

Participants were invited to outline their understanding of metacognition and their responses broadly separated into five categories (Table 3). The most common definition was understanding one's thinking, which aligned with declarative, procedural and conditional knowledge of cognition (Jacobs & Paris, 1987); the second most common definition was awareness of own thinking, which could correspond to either knowledge or regulation of cognition (Schraw & Moshman, 1995). Furthermore, a common definition was 'thinking about thinking', which is a phrase sometimes used in the literature (e.g. Georghiades, 2004). Together these definitions suggest that academics were correctly aware of basic metacognition constructs, although their emphasis on knowledge of one's cognition, rather than regulation of cognition, suggests a partial awareness of metacognition.

These findings on the (lack of) awareness of metacognition are consistent with a theory-practice gap in HE.

RQ2: To what extent do HE academics include metacognition in their teaching practice?

Interview participants were asked whether they explicitly taught students about metacognition, and no participant stated that they explicitly taught metacognition. In order to assess the extent to which students' metacognitive ability was supported implicitly through techniques used in routine teaching practice, questionnaire respondents indicated how often they used each of the 16 MSPs. All respondents indicated that they used at least two MSPs in their teaching practice, and 10/72 (13.9%) said they used all 16 techniques, $M = 11.76$, $SD = 3.38$. A 'MSP score' captured the number and frequency of MSPs used in teaching practice; scores ranged from 5 to 43 ($M = 23.67$, $SD = 7.64$).

Neither the number of MSPs nor the MSP score differed significantly by gender or discipline. The MSP score, but not the number of MSPs, was significantly greater for participants who had heard of metacognition compared to those who had not ($t = 2.23$, $p < .03$), suggesting that familiarity with metacognition was associated with more frequent use of MSPs compared to academics who were unfamiliar with metacognition.

Table 3 Questionnaire respondents' definitions of metacognition

Definition of metacognition	Responses
Understanding one's thinking	12
Awareness of own thinking	7
Thinking about thinking	6
Self-regulation of own thinking	1
Awareness and understanding of own thinking	1

MSPs, teaching experience and teaching qualifications

Neither the number of MSPs nor MSP score correlated significantly with teaching experience. This was unexpected; indeed, one respondent noted:

> Comments reflect age and experience. If asked the same questions at [an] earlier time point in my career I would have answered differently.

Two-thirds of participants held a teaching qualification or were working towards one; these participants used significantly more MSPs ($t(31.78) = -3.44$, $p = .002$) and had a significantly higher MSP score ($t(70) = -3.74$, $p < .001$) than participants who did not declare a teaching qualification. Both results correspond to large effect sizes (Hedges' g was used because of differences in sample sizes; $g = 1.00$, $g = .93$). One interview participant, when discussing Bloom's taxonomy (Bloom, 1956), mentioned their teaching qualification, although they did not expand on how their qualification informed their teaching practice. Conversely, two participants explicitly denied that their teaching qualification contributed to their teaching practice, for example:

> I started reading educational research … and when there are clear, well-designed studies that return clear, useful, easily implemented interventions you can make, we should make those interventions … it's all happened in the last five years and nothing whatsoever to do with my teaching qualification. (Participant 4)

A hierarchical multiple regression was conducted to investigate whether possession of a teaching qualification (or working towards one) and teaching experience predicted MSP use. In addition, the interaction between teaching qualification and teaching experience was examined. Teaching qualification and teaching experience were entered at the first step, and the model was significant, $F(2, 68) = 6.83$, $p = .002$, explaining 17% of the variance in MSP use. At the second step, the interaction term was added (teaching qualification × teaching experience), and this model was also significant, $F(3, 67) = 8.39$, $p < .001$, explaining 27% of the variance in MSP use.

This interaction is presented in Figure 1, indicating that respondents without a teaching qualification increased their use of MSPs with experience, while those with a teaching qualification showed extensive use of MSPs, largely irrespective of teaching experience.

Not all MSPs were used equally

Although all MSPs were used, MSPs differed in their extent of use (Figure 2). At one extreme, 71 of 72 respondents (98.6%) indicated that they asked students to reflect on prior knowledge, while at the other extreme, only 33 respondents (45.8%) said they use ConcepTests.

Subsets of MSPs may align with different elements of metacognition; a 'MSP type score' was calculated for each respondent to capture the use of MSPs aligned with these elements of metacognition. A within-subjects ANOVA found significant differences in the use of MSP types, $F(2.60, 184.78) = 52.10$, $p<.001$, partial $\eta^2 = .42$. Specifically, MSPs focused on 'declarative knowledge and understanding of the discipline' were used most frequently and significantly more than those for 'metacognitive evaluation', which were used more than either those for 'analysis' or 'metacognitive monitoring'; finally 'strategic knowledge' was used significantly less than all other types.

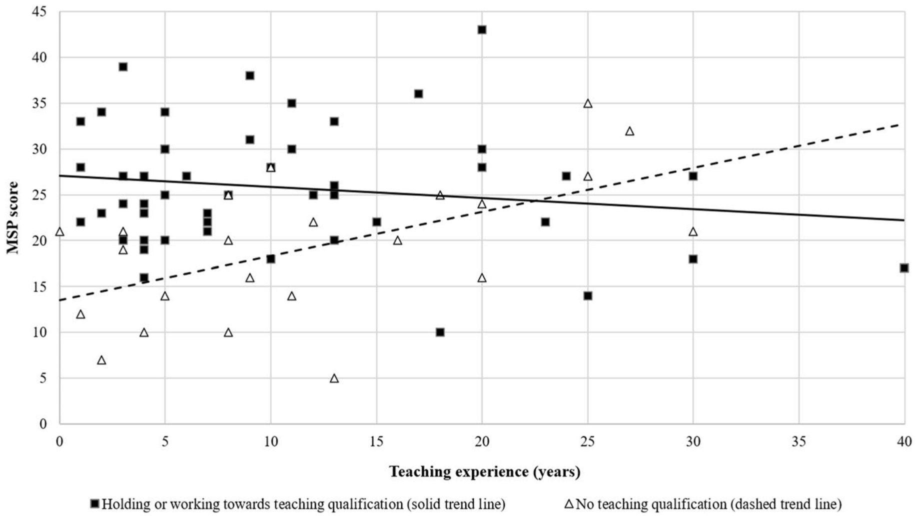

Figure 1 Teaching experience and teaching qualification status predicting MSP use. Respondents' use of MSPs (i.e. MSP score), tended to increase with teaching experience only for individuals who did not declare a teaching qualification (hollow triangles, dashed trend line). Conversely, respondents with, or working towards, a teaching qualification (filled squares, solid trend line) largely reported high use of metacognitive devices. The multiple regression was statistically significant

Two-way ANOVAs explored relationships between participant factors and differential use of types of MSPs: a significant result was found for possession of a teaching qualification. This showed a simple effect of qualification due to those with or working towards a qualification reporting greater use of MSP than participants without a qualification, F (1, 70) = 14.10, $p < .001$, partial $\eta 2 = .168$. The simple effect of MSP type was also significant, following the pattern described above, F (2.52, 176.466) = 51.620, $p < .001$, partial $\eta 2 = .424$. The interaction between MSP type and teaching qualification tended towards significance, F (2.521, 176.466) = 2.820, $p = 0.05$, partial $\eta 2 = .039$. This was due to those with or working towards a qualification reporting significantly greater use of monitoring (e.g. rate confidence in answer, peer/self-assessment) and metacognitive evaluation (e.g. reflect on approach and what to do differently next time) than academics not declaring a teaching qualification (Figure 3).

RQ3: What reasons do HE academics give for implicitly supporting metacognition in their teaching practice?

Given that the majority of academics were unaware of metacognition, their reasons for using MSPs were explored at interview.

Some MSPs were apparently used to assist the academic, rather than develop students' metacognition. For example, one participant described asking students to articulate their understanding of material in order to establish whether the delivered material had been understood sufficiently so that the academic could proceed with the next lecture topic, rather than as an opportunity to develop students' metacognitive monitoring and skills in regulating their cognition:

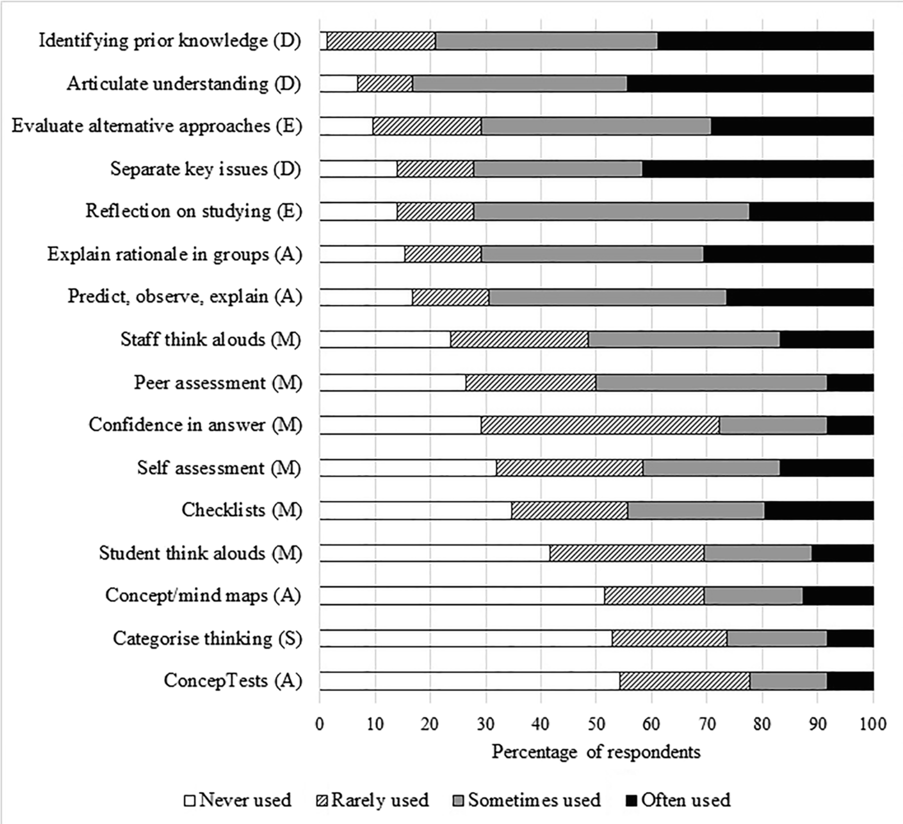

Figure 2 MSPs differed in their extent of use. Note: A, analysis of discipline content; D, declarative knowledge and understanding of the discipline; E, metacognitive evaluation; M, metacognitive monitoring; S, strategic knowledge

> By asking whether they understand is to get a confirmation that they understand. (Participant 2)

One participant, who knew about metacognition but denied explicitly teaching it, used MSPs to increase students' awareness of different exam questions:

> We've got a model [exam] paper and I'm going to demonstrate what type of question is a remembering question and which is a problem-solving and the difference between the two. (Participant 3)

Exercises such as this have the potential to increase students' awareness of different thinking patterns, such as those described in Bloom's taxonomy (Bloom, 1956), thereby increasing students' strategic metacognitive knowledge. These interview comments were broadly consistent with the quantitative data showing a preference for using MSPs focused on knowledge and understanding rather than regulatory elements of metacognition, such as monitoring.

There was evidence that, despite using some monitoring-type MSPs, students did not improve their skills in regulation and monitoring. For example, students used peer marking which should have increased their ability to monitor their performance, although they still sought verification from the academic:

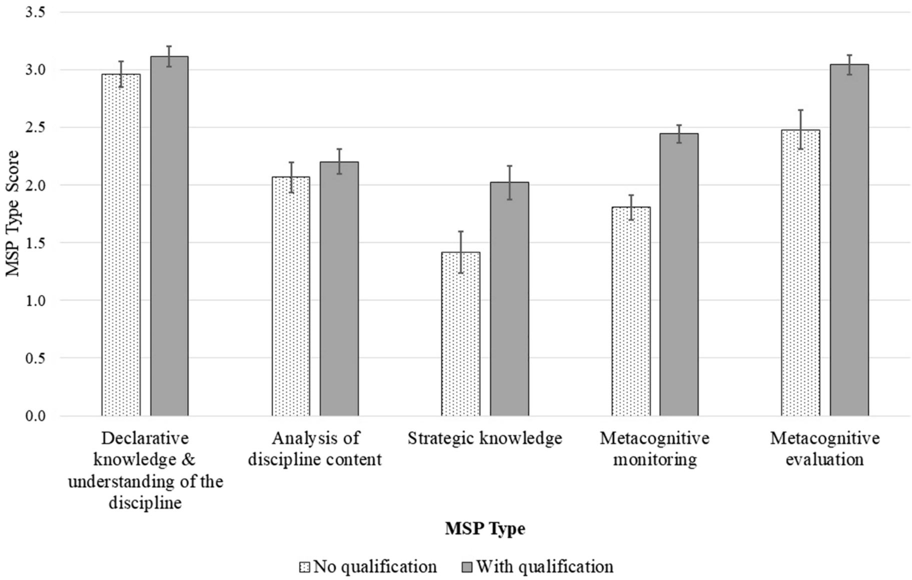

Figure 3 Possession of a teaching qualification affected which type MSPs were used. Note: Error bars represent the standard error of the mean

> I got them to peer mark as well [yet they were] asking me what sort of grade they would be getting and I said 'you peer marked it and from the first presentation they're very similar to what we were giving, so therefore you will know whether you've done well or bad' (Participant 2)

All interviewees said that teaching students to think was important, although this was in the context of developing students' ability to become scientists, rather than as metacognitive, independent learners. Of particular importance were skills of experimental design and critical analysis, especially forming an opinion of the validity of peer-reviewed research:

> I think it's very useful to show them a bad experiment as well and say 'this is something that was published in a good peer-reviewed journal what's wrong with their design, what can you actually conclude from this?' (Participant 4)

When asked how they could further improve students' thinking abilities beyond scientific enquiry, participants envisaged problems with incorporating metacognition into their teaching:

> It is challenging to also layer in thinking, how you should be learning and what you should be evaluating here - they're first year students, they find the subject challenging already so then you don't want to add too many layers to what's going on. (Participant 3)

Participants also questioned the appropriateness of metacognition instruction within their discipline:

> I don't think it really fits in, if we're doing essay-type responses to questions then I think I could see how I would. (Participant 5)

Discussion

This study found that the metacognition theory-practice gap previously reported in primary and secondary education extends into HE whereby, despite extensive investigation of metacognition in the literature, academics are broadly unfamiliar with metacognition and did not explicitly include it in their teaching (Ben-David & Orion, 2013; Georghiades, 2004; Zohar & Barzilai, 2013). Specifically, we found that approximately one-third of academics had heard of metacognition, and most of these were only 'vaguely' aware of metacognition. Academics' definitions of metacognition emphasised knowledge, rather than regulation, of cognition and were more broadly aligned with the colloquial definition of metacognition as 'thinking about thinking' rather than the multi-faceted construct espoused in the literature (Flavell, 1976; Brown, 1987; Jacobs & Paris, 1987; Schraw & Moshman, 1995; Georghiades, 2004). This suggests that academics mostly hold an incomplete awareness of metacognition, consistent with a theory-practice gap.

Given the lack of awareness of metacognition among academics, it was not surprising that this study found no evidence of explicit inclusion of metacognition in HE teaching. Instead, we evaluated the broad and implicit inclusion of metacognition supportive practices (MSPs) in teaching practice: this is the first study of its type at any level of education.

We found that all academics across the scientific disciplines implicitly used MSPs in their teaching practice but often in a limited way. There was a tendency to use MSPs to support students' knowledge and understanding of the subject, for example, by identifying prior knowledge, rather than developing regulatory elements of metacognition, for example, by asking students to rate their confidence in their answers. Furthermore, even where MSPs were used, they were not sufficiently scaffolded to enable students to develop skills which can be applied to other learning situations. There is a literature corpus which reviews approaches to teaching metacognition (Whitebread & Pasternak, 2010; Zohar & Barzilai, 2013); findings suggest that students benefit from explicit instruction in metacognitive techniques (Nordell, 2009) and subsequent scaffolding to enable performance monitoring and reflection on strategy effectiveness (Sandi-Urena et al., 2011). As these approaches to teaching metacognition were not used by staff, it was not surprising that interviewee comments suggested that students were unable to transfer metacognitive ability between situations.

This implicit use of MSPs without explicitly teaching students about metacognition and without scaffolding is further evidence of a gap between the theoretical and empirical literature on metacognition and teaching practice in HE. This is important because, in primary and secondary education, educational interventions delivered by experts have been more successful than those by non-experts for both teaching interventions generally (de Boer et al., 2014) and metacognition interventions specifically (Dignath & Büttner, 2008). Investigations in HE have also identified small positive effects of general pedagogical training on teaching practice (Ilie et al., 2020), especially among inexperienced teachers (Ödalen et al., 2019). The impact of metacognition training on academics' teaching practice and students' outcomes in HE is an area for future research.

At interview, academics questioned the appropriateness of teaching metacognition in HE. One interviewee commented that metacognition might only be appropriate for final-year students. This finding is consistent with reports from teachers in secondary education who questioned the age appropriateness of metacognitive instruction (Ben-David & Orion, 2013) but is inconsistent with reports that even primary school children possess metacognitive skills (Flavell et al. 1970). Furthermore, one participant thought metacognition would be more appropriate in non-quantitative subjects rather than chemistry, despite the wealth of research into metacognition in chemistry in HE (e.g. Davidowitz & Rollnick, 2003; Parker Siburt et al., 2011; Rickey & Stacy, 2000; Sandi-Urena et al 2011).

Again, the differences between our findings in teaching practice versus the best practice reported in the literature are evidence of a metacognition theory-practice gap in HE.

Consistent with the incomplete awareness of metacognition and limited use of MSPs, all interviewees said they valued thinking skills, although this was in the context of developing students' ability to become scientists, rather than as metacognitive, independent learners. This finding is consistent with Zohar (2006), who studied high school science teachers participating in a professional development course designed to enhance inclusion of metacognition in teaching. Initially these teachers were unable to talk about thinking skills; instead they spoke about scientific inquiry. This emphasis on developing science-focused skills, as opposed to supporting students' metacognitive development, potentially represents a missed opportunity. In recent years, there has been an emphasis on developing graduates for 'life-long learning', in recognition of the need to update skills and knowledge throughout professional life, even to the extent of changing careers (Government Office for Science, 2017). If, as some metacognition researchers suggest, adults can transfer knowledge and regulation of their cognitions between contexts (Carpenter et al, 2019), it may be advantageous for HE students if institutions explicitly equip them with skills in learning to learn, in addition to discipline-specific skills, to enhance their aptitude for life-long learning (Cornford, 2002).

In contrast with primary and secondary education, where all teachers must demonstrate that they have met the Teachers' Standards (Department for Education, 2011), only 58% of HE academics held a teaching qualification in 2018–2019 (Higher Education Statistics Agency, 2020); two-thirds of our participants either held a teaching qualification or were working towards one. Typically, HE teaching qualifications align with the UK Professional Standards Framework which specifies that educators should 'design and plan learning activities … develop effective learning environments' and possess knowledge of 'how students learn' (Higher Education Academy, 2011, p. 3), although there is no explicit requirement for HE educators to know about metacognition.

Despite metacognition not being integral to HE teaching qualifications, academics who either held a teaching qualification or were working towards one reported significantly greater use of MSPs overall and significantly greater use of MSPs aligned with developing metacognitive monitoring and evaluation. The exact nature of this relationship requires further study. One hypothesis is that academics who incline towards completing a teaching qualification also incline towards student-centred education involving MSP practices. Alternatively, while obtaining their teaching qualification, academics acquire knowledge of 'how students learn' (Higher Education Academy, 2011, p. 3) and thus become more student-centred (Gibbs & Coffey, 2004; Ödalen et al., 2019); these shifts in teaching practice may co-incidentally and implicitly support students' metacognitive development.

The main contribution of this study is that it provides evidence that staff training and development in their teaching practice generally, not necessarily explicitly in metacognition, has the potential to better support students' metacognitive development. Our data indicate that current teaching qualifications encourage lecturers to implicitly adopt MSPs frequently and early in their career. Lessons learned from primary and secondary education suggest that professional development programmes can increase educators' awareness and positive attitudes towards metacognition (Ben-David & Orion, 2013). Based on our data and previous studies, future professional development programmes should comprise explanations of metacognition constructions and their contribution to student outcomes, pedagogic knowledge of how to include metacognition in teaching practice and communities of practice to support subsequent implementation in teaching practice. Evidence from study skills programmes suggests that metacognition should be embedded within existing curricula, as opposed to using a 'bolt-on' approach (Wingate, 2006). Staff could explicitly include metacognitive skills in student learning outcomes: this ensures that they are accountable for its inclusion in their teaching (Rao et al., 2017).

The main limitation of this study was the use of a self-report questionnaire which may be subject to biases, especially social conformity. Despite the limitations of using a self-report questionnaire (Demetriou et al, 2015), it enabled data collection from more academics than would have been possible by relying on interviews or using alternative methods such as teaching observations. Nonetheless, future work could include more interviews and/or teaching observations to further substantiate the findings presented here. To avoid respondent fatigue, the questionnaire was not exhaustive in measuring variables which could have contributed to results, such as type of academic contract (i.e. focus on teaching or research) or approaches to teaching (e.g. student- or teacher-centred). Finally, the participants were all employed at one UK research-intensive university. Although the findings can inform future teaching practice at this university, it remains to be seen to what extent the findings generalise across the sector.

To conclude, we found that the metacognition theory-practice gap exists in HE, where academics are broadly unaware of the wealth of research into undergraduate students' metacognition. Nonetheless, all academics included practices in their teaching which have previously been investigated in the context of supporting students' metacognitive development. The differential use of these metacognitive supportive practices between academics holding or working towards a teaching qualification, versus those without a qualification, raises the possibility that staff development programmes have the potential to better support students' metacognitive development relevant for their studies and post-graduation careers.

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Availability of data The data that support the findings of this study are available from the corresponding author upon reasonable request.

Code availability Not applicable.

Declarations

Ethics approval Ethical approval was sought, and granted, from the appropriate committees at the Queen Mary University of London, where the research was conducted, and University College London, which had academic oversight of the research; respective approval numbers were QMREC1787 and DENNIS_270218_EDPSY_1MS_2JM.

Conflict of interest The authors declare no competing interests.

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