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Can a mock medication-taking learning activity enable pharmacy students to experience the range of barriers and facilitators to medication adherence? An analysis informed by the Theoretical Domains Framework and COM-B model

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ABSTRACT

Background: Pharmacy professionals are well-placed to provide medication adherence support to patients. The Capability, Opportunity, Motivation-Behaviour (COM—B) and Theoretical Domains Framework (TDF) are two complementary models previously applied to medication-taking behaviour. Understanding the patient-specific barriers and facilitators to adherence using psychological frameworks from the early stages of pharmacy education enables the design and delivery of effective interventions.
Objectives: To examine whether a novel 'mock medicine' learning activity enabled students to experience the range of barriers and facilitators to medication adherence using the COM-B and TDF.
Methods: A mock medicine activity was conducted with students at pharmacy schools in three universities in the UK, Norway, and Australia over one week. Percentage adherence was calculated for five dosing regimens; theoretical framework analysis was applied to map reflective statements from student logs to COM-B and TDF.
Results: A total of 349 students (52.6%) returned completed logs, with high overall mean adherence (83.5%, range 0–100%). Analysis of the 277 (79.4%) students who provided reflective statements included barriers and facilitators that mapped onto one (9%), two (29%) or all three (62%) of the COM-B components and all fourteen TDF domains (overall mean = 4.04; Uni 1 = 3.72; Uni 2 = 4.50; Uni 3 = 4.38; range 1–8). Most frequently mapped domains were '*Environmental context and resources*' (n = 199; 72%), '*Skills*' (n = 186; 67%), '*Memory, attention and decision-making*' (184; 66%) and '*Beliefs about capabilities*' (n = 175; 63%).
Conclusions: This is the first study to utilise both COM-B and TDF to analyse a proxy measure of medication adherence in pharmacy education. Data mapping demonstrated that students experienced similar issues to patients when prescribed a short course of medication. Importantly, all the factors influencing medication-taking reported by students were captured by these two psychological frameworks. Future educational strategies will involve students in the mapping exercise to gain hands-on experience of using these psychological constructs in practice.

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1. Introduction

It has been estimated that half of all patients with chronic conditions do not adhere to their prescribed dosing schedule.[1,2] The World Health Organisation (WHO) highlighted the need to increase the effectiveness of adherence interventions internationally, especially among patients with chronic conditions.[3] Reasons for non-adherence can be categorized into two types: intentional and unintentional.[4] Unintentional non-adherence can be defined as when medicine taking behaviour is affected by barriers that are beyond the control of the patient, whereas intentional non-adherence relates to the conscious decision by the patient to medication differently than prescribed, or not taking it at all.[5,6] Non-adherence to medication is associated not only with increased treatment costs, but with poorer clinical outcomes such as morbidity and mortality. With the increasing prevalence of chronic conditions and with increased polypharmacy meaning medical regimens are getting more complicated, non-adherence is a concern for healthcare systems around the globe.[7] Developing partnerships between healthcare professionals and patients is at the core of the challenge to support optimal medication adherence.[1,8]

Pharmacists interface with patients at all points of the medication supply chain and can utilise tools such as medication reconciliation and medication reviews to understand and resolve issues identified concerning medication adherence.[2] Pharmacy input into the process of medication management is welcomed by medical practitioners[9,10] and pharmacist-led interventions have been reported to improve patients' medication adherence.[11–13] However, to maximise their role in improving patient medication adherence, pharmacists need to adopt the use of adherence interventions that are theory driven.[2,6,14]

In order to design effective interventions, it is important to utilise an appropriate psychological framework to identify the most effective behaviour change techniques (BCTs).[15] These can be used to understand the barriers, as well as the factors that will facilitate, behaviour change.[15] When applying this to medication adherence, the first step in the process is the identification of the barriers to optimal adherence from the patient's perspective. Once the reasons for non-adherence have been established, the appropriate behaviour change technique/s (or intervention) can be selected.

The Capability, Opportunity, Motivation-Behaviour (COM—B) model is a framework for understanding the barriers and facilitators to a specific behaviour which allows the behaviour (such as medication-taking) to be systematically explored.[15,16] The COM-B model is based on the concept that the interaction between an individual's capability (psychological or physical capability to engage in a behaviour) opportunity (physical or social factors which facilitate or hinder behaviour) and motivation (automatic or reflective processes that activate or inhibit behaviour) can provide an explanation for why a particular behaviour is or is not performed. The COM-B model has previously been applied to the behaviour of taking medication.[17] 'Capability' and 'Opportunity' can be related to 'unintentional' non-adherence and 'Motivation' captures aspects of 'intentional non-adherence'. The Theoretical Domains Framework (TDF) is an additional tool for investigating barriers to behaviour change in more detail and is linked to the COM-B model. Two versions of the TDF exist, the original 12-item version[18] and the subsequent version which was expanded to include 14 key domains.[19] TDF and COM-B are therefore two complementary models which form part of the Behaviour Change Wheel (BCW), which in turn map onto the Behaviour Change Techniques (BCT) Taxonomy.[15] Literature reports a range of studies whereby a combination of the models has been employed to identify enablers and barriers to specific behaviours that aid the design of effective interventions in a range of settings and with different population cohorts.[20–25] It is, therefore, important, that pharmacists can navigate through COM-B and TDF to understand the full range of reasons behind non-adherence and support patients.

To date, there has been limited literature reporting educational activities to support pharmacy students' learning about the barriers and facilitators to medication adherence and the related psychological theories. It is proposed that the integration of the COM-B and TDF into pharmacy education starting from the undergraduate years will enable students to reflect on the development of evidence-based interventions that help understand medication-taking behaviours, which in turn will equip them with the skills to address patient non-adherence. One such learning activity was described by Mantzourani and colleagues to help pharmacy students in one university in the United Kingdom (UK) understand the challenges experienced by patients who are prescribed medication.[26] The activity was successful in supporting students to understand the challenges of taking medication and to reflect on their own reasons for non-adherence, with a main finding that reporting of intentional reasons for non-adherence was lower than that of unintentional reasons. However, there was no structured way for establishing whether the learning activity enabled students to reflect on the range of possible barriers and facilitators to medicine-taking as outlined by psychological frameworks. Since publication, the learning activity has been adopted in other Schools of Pharmacy in Australia and Norway, setting the foundation for interventions underpinned by health psychology theory to be implemented internationally by future pharmacy practitioners. This paper presents analysis of data captured for the further use of the 'mock medicine' learning activity with cohorts of pharmacy students from three countries, where students' reflective statements were mapped to the COM-B model and TDF.

Therefore, the aim of this study was to examine whether a novel 'mock medicine' learning activity enabled students to experience the full range of barriers and facilitators to medication adherence presented in the COM-B and TDF.

2. Method

This study utilised a mixed methods approach using a combination of qualitative (theoretical framework analysis) and quantitative (using descriptive statistics) methodologies to evaluate pharmacy students' written reflections on a mock medicine learning activity, with data collected over a three-year period in a UK university plus for a one-year period in a university in Norway and Australia.

2.1. Sampling and data collection

The teaching activity was originally introduced in 2013, but no formal data were collected for evaluation of its usefulness. For this study, data were collected from undergraduate students in Cardiff School of Pharmacy and Pharmaceutical Sciences, UK, across three years (i.e., three different cohorts of students in 2014/15, 2015/16 and 2017/18), and for one year at the School of Pharmacy, University of Sydney, Australia (2015–16) and the department of Pharmacy, UIT The Arctic University of Norway (2017–2018). Students in all three universities were in the first year of their undergraduate studies. The activity was preceded by a lecture on medication adherence and related psychological theories. The three universities have been randomly allocated a number from 1 to 3 when presenting data, for anonymisation. Total population sampling was used to collect data for this project. All students ($n = 664$) registered in a particular year cohort in the respective universities were invited to participate in a non-compulsory learning activity, as described in the first stage of this research.[24] Namely, students were randomly given a mock medicine (i.e.,'Tic Tacs'™ in 2014/15 for University 1 which were subsequently replaced by 'Skittles'™ sweets for all cohorts in all three Universities) labelled with one of five different pre-defined dosing regimens, using the standard dispensing abbreviations adopted in UK, Australia and Norway[27] (one in the morning [*od*], one at night [*on*], one twice a day [*bd*], one three times a day after food [*tds*], or one four times a day an hour before food [*qds*]). These five different dosing regimens were selected to provide a breadth of varying complexity of student experiences. Students were asked to take the 'mock medication' for a period of one week. They were also

given a data collection form, consisting of a table which required students to record their adherence against the dosing instructions for each day of the week, and space to note their reflections on the task (Appendix 1).[26] Students were asked to provide as much information as possible in relation to factors that helped or hindered them in this learning activity and relate to the theory that they had been taught prior to the activity. These reflections formed the basis of some discussion during the taught session that followed. Whole-cohort findings were shared with the students, categorized under intentional and non-intentional adherence, and mapped onto the COM-B model and TDF. During the session, examples of the students' own reflective statements were used to bring to life the psychological theories relating to medication adherence.

2.2. Ethical approval

University research ethics approval was granted for obtaining data from students from all participating institutions where necessary (University 1 and 3). All data collection forms stated that the information collected would be anonymised and used for further analysis and research purposes. Explicit consent was obtained at the bottom of the form for their data to be included in research. If students did not wish for their data to be used in this way, they were asked to contact the University Site Lead. The data collection form was standardised for all sites. All student data were anonymised by the allocation of a unique identifier code for each data collection form. Ethics approval was gained from Cardiff Metropolitan University, Health Sciences Research Ethics Committee for subsequent secondary analysis by mapping on to the two psychological frameworks (Reference number 10267).

2.3. Data analysis

All collected forms with student permission granted were included in the analysis. Forms were anonymised before entering data into a Microsoft Excel© 2016 spreadsheet, to allow analysis using descriptive statistics.

2.3.1. Step 1: calculation of adherence data

A percentage adherence rate for the entire week of mock medicine taking activity was calculated for each student, to explore the range of adherence scores overall. This was calculated by dividing the number of doses correctly taken by the number of possible doses for that dosing regimen. The sum of individual percentage adherence rates for each dosing regimen was then divided by the number of students allocated to that regimen, to calculate the mean percentage adherence per dosing regimen (Appendix 2). Overall percentage adherence was estimated by dividing the sum of mean percentage adherence per dosing regimen by five (i.e., the distinct number of dosing regimen). An example of these calculations is provided in Appendix 2.

2.3.2. Step 2: reflective statements

All free-text comments were transferred verbatim into a Microsoft Excel® 16 spreadsheet and theoretical framework analysis was undertaken.[25–30] All reflective statements were mapped to the corresponding domains of the TDF and components of the COM-B model following guidance from the published literature[31] with focus on medication-taking behaviour in a learning environment (Fig. 1).

Initial analysis was undertaken independently by two of the research team (MA, DJ). A small sample of reflective statements were initially coded by both researchers to ensure an agreed approach to the mapping. Appendix 3 shows four examples of how reflective statements were mapped to the TDF domains, with an inter-rater discrepancy rate of 21% for TDF and 11% for COM-B with further explanation of the approach taken to coding and some of the challenges experienced. Inter-rater reliability was also checked (Appendix 3) where each researcher rated a randomly generated sample of 10% of the reflective statements for a second time.[32,33] Final coding was undertaken by DJ and HS until 100% agreement was reached. Frequency tables were used to calculate the number of times reflective statements were coded for each COM-B component and each TDF domain, to highlight those that were prominent throughout the reflective statements. The number of COM-B components that each students' comments mapped onto was calculated, and frequency counts of how comments mapped onto each theoretical domain in the TDF framework were reported.

3. Results

Data forms submitted by 349 students (out of 664, response rate

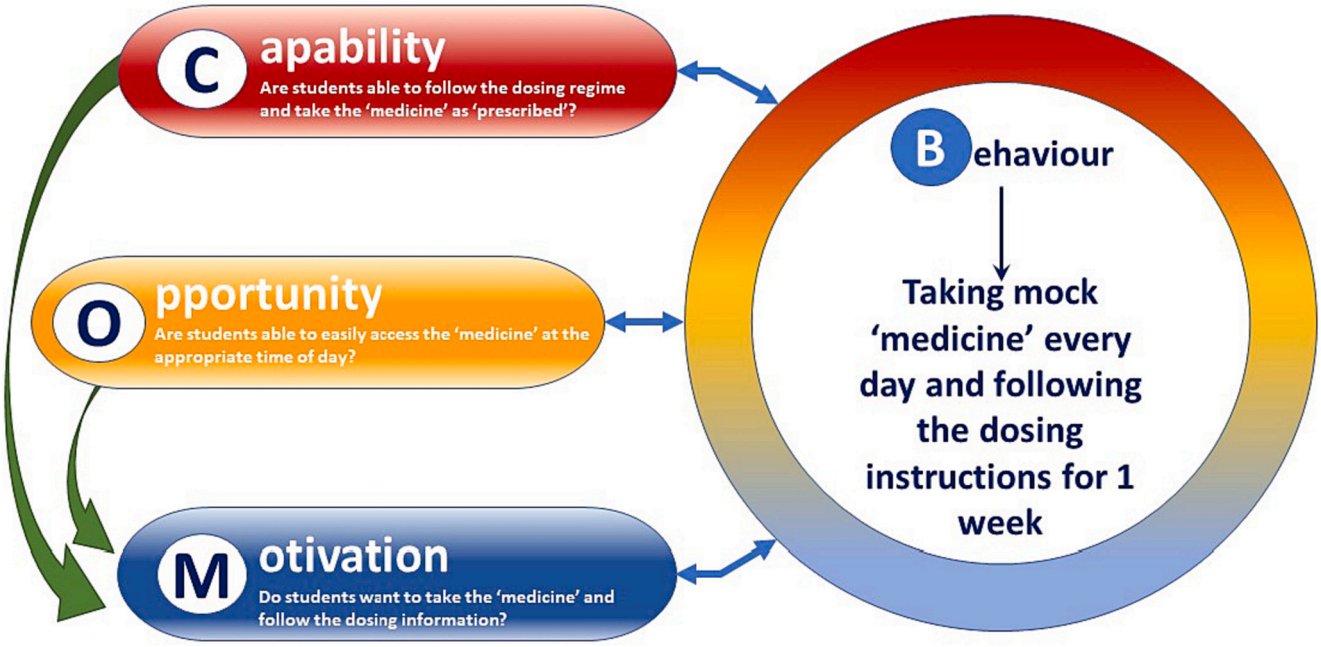

Fig. 1. The COM-B model applied to the examination of medication-taking behaviour in a learning environment (adapted from Michie, 2011).[15]

52.6%) were included in the analysis (Appendix 4). The number of participants who returned the forms for each university and year of participation are presented in Appendix 4, with the mean percentage adherence, standard deviations, and range of adherence scores. The overall mean adherence to taking the mock medicines was 83.5%. A total of 277 students (79.4%) provided reflective statements and these were included in the qualitative analysis. For those who returned their forms, the overall frequency of mock medicines dosing regimens reported by students was as follows: *od* = 57/277 (20.6%); *on* = 39/277 (14.1%); *bd* = 59/277 (21.3%); *tds* = 61/277 (22.0%); *qds* = 58/277 (20.9%) (missing entries n = 3).

3.1. Reflective statements

3.1.1. Mapping to 'COM-B' components

Fig. 2 illustrates the number of COM-B components that the reflective statements were mapped on to i.e., reflective statements could be mapped to either one (9%), two (29%) or all three components (62%) of the model.

3.1.2. Mapping to TDF domains

Reflective comments were individually mapped to one or more of the TDF domains; across the whole dataset all 14 domains were utilised. Only 7 (2.5%) reflective statements could be mapped onto one domain alone. Reflective statements were mapped onto a mean of 4.04 domains (range 1 to 8; Uni 1, mean = 3.72; Uni 2, mean = 4.50; Uni 3, mean = 4.38). The domains which the reflective statements were most frequently mapped onto were '*Environmental context and resources*' (*n* = 199 times; 72%), '*Skills*' (*n* = 186; 67%), '*Memory, attention and decision-making*' (184; 66%) and '*Beliefs about capabilities*' (*n* = 175; 63%) (Fig. 3).

Table 1 presents examples of quotes from the analysis of the reflective statements for each of the 14 TDF domains (and respective COM-B components). Illustrative quotes were taken from a representative sample from each university for a range of different dosing regimens where appropriate.

The mapped reflective statements were then summarised for each TDF domain (Fig. 4), with further illustration of how these relate to the components of the COM-B model.

4. Discussion

To our knowledge, this is the first time that the application of two behavioural frameworks (COM-B and TDF) has been used to provide evidence of the usefulness of a learning activity in this way within an educational context across three different countries. Our study was an important initial step in helping students learn how to use the psychological theories and frameworks to develop and implement better medication adherence interventions. The findings demonstrate that engaging pharmacy students in a 'mock medicine' educational activity and sharing collective findings to the whole cohort is a helpful way to expose them to the full range of barriers and facilitators to medication adherence experienced by patients. Although adherence rates varied across the student cohorts and the three universities, which ranged from complete non-adherence to full adherence, the overall mean adherence rate was high. Students adopted a wide range of situational cues to remind them to adhere to their dosing regimen. Theoretical framework analysis found that all the barriers and facilitators to adherence reported in the reflective statements could be mapped to at least one of the three components of the COM-B model and at least one of the 14 TDF domains. Moreover, nearly two-thirds of reflective statements were mapped on to all three COM-B components, and a mean of four different domains. Thus, demonstrating that, collectively, students were exposed to the full range of reasons for non-adherence and in doing so, this learning activity was successful in helping to bring psychological theories to life.

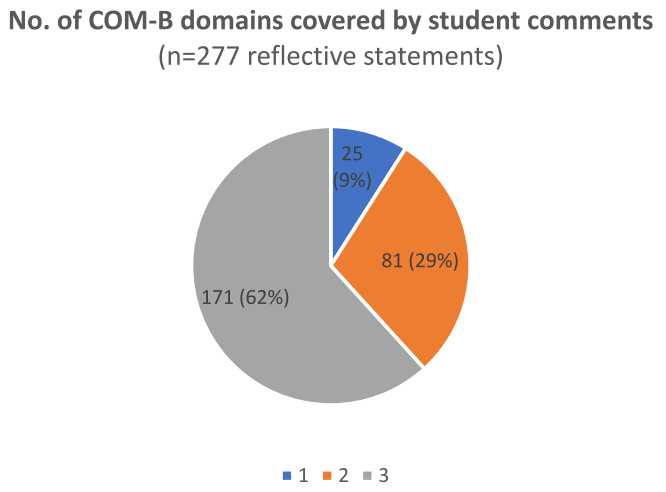

Fig. 2. Frequency distribution for mapping of reflective statements to COM-B components (*n* = 277).

Reflective statements were mapped most frequently to the '*Environmental context and resources*' domain of the TDF (which links to the Physical Opportunity component of the COM—B), where factors relating to the external environment either discouraged or encouraged adherence. For example, when the medication had to be taken out of the usual context, because the students were not actually ill or in need of the medication, this could easily result in non-adherence. This domain appeared to be an important precursor to the development of skills and abilities to adapt to the intended behaviour and to adhere to the 'mock medication task'. Of note, the '*Skills*' domain of the TDF (linked to the Physical Capability component of the COM—B) was the second most frequently mapped to the reflective statements. Students described a need to develop a 'new' skill set if they had no previous experience of taking medication prior to completing the task.

'*Memory, attention, and decision processes*' was the third most frequently mapped domain of the TDF (linked to the Psychological Capability component of the COM—B) where many different reasons for forgetting to take the mock medicine were reported. The perceived importance of taking the 'medication' and the degree to which taking it was perceived to be a priority were important factors in participants remembering to adhere to medication. Not surprisingly, it was easier to remember to take the mock medicine if the instructions were not very complex. However, even with a simple once daily dosing instruction, the issue of remembering to take it was raised.

Some students found it difficult to remember to take the mock medicines initially, but this improved with time, which suggests a habit formation ('*Behavioural regulation*' domain of the TDF which is linked to the Psychological Capability component of the COM—B). Recent research has highlighted the importance of habits, an aspect of the automatic motivation component of the COM—B, in adherence interventions,[11,34] although it takes more than one week to fully form a habit.[35] This is a good example of where the relationship between the different components of the COM-B are inter-related and how they can change over time, with good behavioural regulation (psychological capability) leading to habit formation (automatic motivation). Hence the -directional arrows in Figs. 1 and 4 showing that Capability and Motivation, and Opportunity and Motivation are linked, whereas Capability and Opportunity are not. Participants also reported their attempts to achieve 'behavioural regulation' through other related TDF domains, for example, placing the medication bottle in a particular place (e.g., next to the phone charger), demonstrated action planning techniques to regulate a desired behaviour. Participants used simple situational cues to prompt their behaviour. However, those with medication dosing regimens that required complex action planning (e.g., changes in eating habits) found it more challenging to maintain adherence.

The '*Intentions*' domain of the TDF (linked to the Reflective

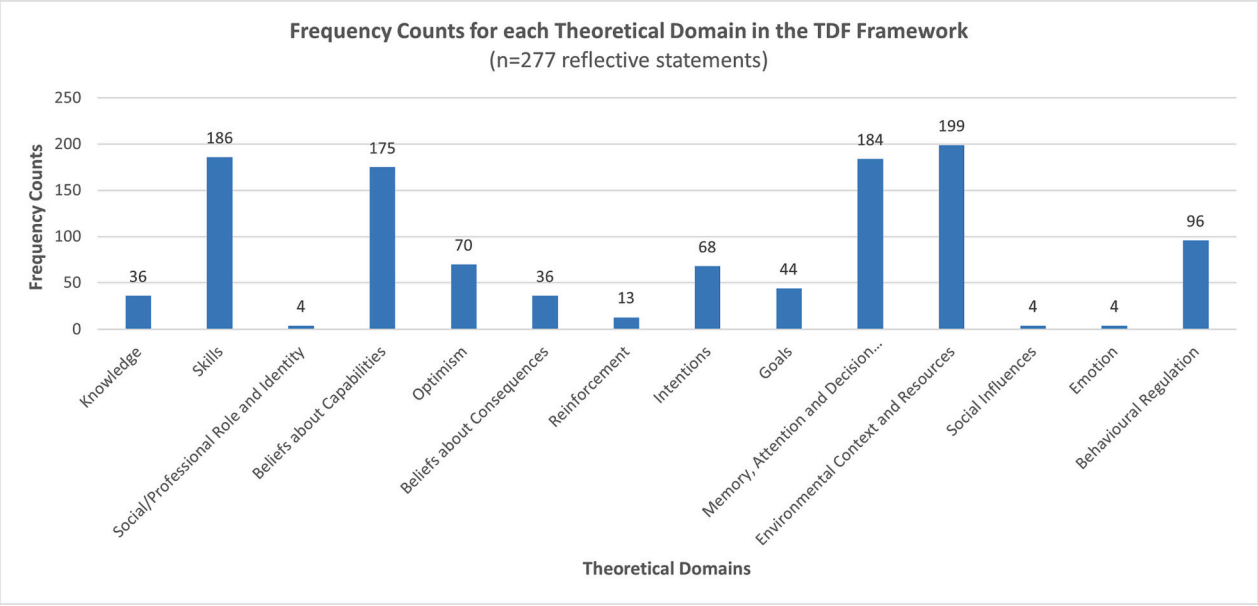

Fig. 3. Frequency distribution for mapping of the 277 reflective statements to the 14 domains of the TDF (each statement could be mapped to one or more domain).

Motivation component of the COM—B) was used to represent reflective statements where students reported that they planned to take the medication, but other factors hindered adherence. Setting reminders also demonstrated an intention to adhere to the medication regimen. Other statements reflected the lack of intention to take the mock medicine, where reasons given were a lack of priority, or due to the lack of tangible benefits. Students implemented several different strategies to carry out their intentions to take the medicines. For example, setting an alarm on their phone, using meals as a reminder, and changing eating habits to overcome these barriers. Where such strategies were not put in place, students reported struggling with the task. However, even those who employed these strategies, still found it difficult to adhere to medication. The '*Goals*' domain of the TDF (linked to the Reflective Motivation component of the COM—B) was mapped to the data when participants stated that they wished to achieve full adherence but had expected the task to be easier than they found it to be.

Mapping to the '*Beliefs about Consequences*' domain of the TDF (linked to Reflective Motivation of the COM—B) did not occur very often, which is maybe unsurprising considering that this was a 'mock medication' with no side effects (i.e., low concerns) and with no beneficial consequences (i.e., low necessity). The few reflective statements that were mapped onto this domain included students commenting that they did not believe they were important to their overall health since they knew they would not have the same effects as real medication. Pharmacy students may have considered this too obvious to state on the reflective log. However, they may not be aware of the important role of this sub-conscious reason for intentional non-adherence, as suggested by the Necessity-Concerns Framework.[4,36]

This also overlaps with the '*Knowledge*' domain (linked to Psychological Capacity component of the COM—B), since being aware that there was no benefit in taking the 'mock medication' made students less likely to take them. Some participants also regarded the lack of specific instructions as a reason for potentially delayed timings, or poor adherence. For example, it was noted that some students were unsure what 'night' meant in terms of what time to take the dose. Very few reflective statements were mapped onto the '*Social influences*' domain (which is linked to the Social Opportunity component of the COM—B). Social influences have previously been found to have a significant influence on adherence to medication.[37] Students may not have been conscious of the effect that group conformity (or group identity) could have on completing a cohort-based learning activity such as this.

In contrast, it is perhaps not surprising that the '*Emotion*' domain (linked to Automatic Motivation) was only mapped to the data in a few cases. It is unlikely that a 'mock-up' such as this would evoke complex emotional reaction patterns leading to stress, anxiety or fear which might come in to play when given an actual diagnosis or treatment in real life. This may also have been limited by the data collection method employed since emotions may be difficult to portray in the written reflective statements. Similarly, very few of the reflective statements mapped on to the '*Social and professional identity*' domain (linked to the Reflective Motivation of the COM—B). This could be explained by the fact that the participants were students and practising pharmacists might be more ready to offer this as a reason for engaging in the learning activity since they would see it as being central to their role.

In summary, most reflective statements could be mapped onto more than one TDF domain and COM-B component. This reflects the breadth of the different reasons for non-adherence that could be gleaned from one individual student. However, this resulted in certain domains appearing to be mapped together more often than others. For example, the '*Memory, attention and decision Processes*' domain was often mapped to the same reflective statement as '*Behavioural regulation*'. Aspects of '*Behavioural regulation*', such as self-monitoring and action planning, were also prominent in the '*Goals*' domain.

4.1. Strengths and limitations

Most students completed the learning activity and returned their forms, which included appropriate reflective statements that could be mapped to both psychological frameworks. This demonstrates not only the high engagement with the task, but also the willingness of students to self-report the extent of, and reasons for, non-adherence. Where students did not return their reflective logs, we do not know how they engaged with the learning activity, if at all, and whether they were able to benefit from reflecting on the task. The activity was initially intended and trialled as a learning activity in one University in 2013, which then evolved into a research evaluation project, when the utility of providing feedback to students on the barriers / facilitators that their peers faced was recognised. In the pilot the data had not been shared with the whole student cohort and as such they were only familiar with their own personal experiences of the barriers and enablers to medication adherence. However, the activity was enhanced in subsequent years to provide this feedback to all students, (including those who did not complete

Table 1
TDF domains and respective COM-B components, with supporting quotes from the reflective statements.

TDF Domain	Example Quotes from Reflective Statement	COM-B Mapping
1. **Environmental Context and Resources**	*"It was difficult to take the Tic-Tac regularly because I cook at different times"* ***(tds; Uni 2).***	**O** – Physical Opportunity
2. **Skills**	*"Went great. Took the Tic-Tac with the other medications I take daily, so it wasn't difficult to remember"* ***(od; Uni 2).*** *"The instructions meant that I have to plan exactly when I eat throughout the day, when I usually just east whenever I'm hungry,* i.e. *I do not have specific eating schedule* ***(tds; Uni 1).***	**C-** Psychological Capability Physical Capability
3. **Memory, Attention and Decision Processes**	*"Only issue was remembering to take it"* ***(od; Uni 1).*** *"I remembered to take them the first day but forgot later on as I eat at different times each day."* ***(tds; Uni 2).***	**C –** Psychological Capability
4. **Beliefs about Capabilities**	*"It was much more difficult that I thought it would be, mainly because it wasn't actually medicine since I wasn't ill and therefore, I wasn't thinking about it and don't need to take it"* ***(od; Uni 1).*** *"Difficult to remember to take medicine"* ***(bd; Uni 1).***	**M –** Reflective Motivation
5. **Behavioural Regulation**	*"I had difficulty remembering to take them to start with but got better as time went on"* ***(od; Uni 1).*** *"Found I had to change my eating habits, don't usually eat 3 meals a day"* ***(tds; Uni 1).***	**C –** Psychological Capability
6. **Optimism**	*"Easy. One to be taken at night only. Not difficult at all compared to the other instructions. Much more free time at night compared to morning"* ***(od; Uni 3).***	**M –** Reflective Motivation
7. **Intentions**	*"Adherence rate = 4/7 × 100 = 57%. I planned to take the 'medication' at a certain time but find it difficult to adhere to especially when I had lots of tasks to do"* ***(od; Uni 3).*** *"Aimed to take one at lunchtime however… I forgot to take it"* ***(tds: Uni 1).***	**M –** Reflective motivation
8. **Goals**	"*I used my meals as a reminder to take the tablets. Changes to routine from weekdays to weekends resulted in near misses*" **(tds; Uni 1).** "*I will bring the bottle with me wherever I go and make a reminder in case I forgot*" ***(bd: Uni 1).***	**M** - Reflective motivation
9. **Beliefs about Consequences**	*"If it was proper medicine (life threatening) then I would've taken it every day but for something (*e.g.*, the pill) I might forget"* ***(od; Uni 1).*** *"We knew that we weren't taking real antibiotics, I was therefore much less resilient that I would be if taking antibiotics properly"* ***(bd; Uni 1).***	**M** – Reflective motivation
10. Knowledge	*"The instructions were not very precise. For example, it didn't state if there needed to be a specific time interval between taking them both or if they had to be taken at certain times…* ***(bd: Uni 1).*** *I think the only confusion would arise from what time of the day to take the tablet and keeping that time consistent"* ***(on: Uni 3).***	**C –** Psychological Capability Physical Capability
11. Reinforcement	*"I think if I was experiencing pain like any individual with a chronic illness I would be forced to take my medication"* ***(bd; Uni 1).*** *"It was easy to take it every night because I take other medications at night"* ***(on; Uni 2).***	**M** – Automatic Motivation
12. Social Influences	*"Some of my friends reminded me to take the dose if I didn't send them a message that I had taken it"* ***(qds; Uni 2).*** *"I tended to take them in lectures when other people were taking them"* ***(od; Uni 1).***	**O –** Social Opportunity
3. Emotion	*"Fairly easy, as I only was required to remember to take it once a day. The fact that I was excited about taking part in this study also contributed to me remembering to take it"* ***(od; Uni 3).*** *"Taking the medication with me when I go out was annoying"* ***(tds; Uni 3).***	**M –** Automatic Motivation
14. Social / professional role and identity	*"I have no issue with adherence… but this I did because (a) I couldn't take it seriously and (b) I ran out of Tic-Tacs. I have spent 6 months where I have had to take doxycycline every day and had no issues because it was necessary for my health. But Tic-Tacs weren't sorry"* ***(tds; Uni 3).*** *"I can now empathise with the patients"* ***(od; Uni 1).***	**M-** Reflective Motivation

Key - Dosing Regimen: *on* – one at night; *od* – once daily; *bd* – twice daily; *tds* – three times a day after food; *qds* – four times a day an hour before food.

or submit their data forms) with examples of reflective statements as part of their education and we would encourage adopting this approach to enhance the value of undertaking this learning activity.

Another strength of the study was the independent review of coding as suggested by Atkins and colleagues.[31] The independent coding by two people allowed discrepancies to be discussed and coding approaches to be refined utilising a third coder where appropriate to reach full agreement. This involved numerous meetings to discuss mapping of the reflective statements onto the COM-B and TDF, plus reviewing a sample of the dataset at various points in the process of analysis resulting in full agreement. (See Appendix 3 for further discussion of coding challenges). However, there may be an element of subjectivity to how the data were coded (or mapped) to the COM-B and TDF. In our study we considered *Reinforcement* to include anything that prompted reflective motivation such as (or lack of) symptoms or prompts in the form of *Environmental/ Social cues* (or physical reminders), which Allemann et al.[38] mapped solely to the *Memory, Attention and Decision Processes* domain. Interestingly, Allemann and colleagues did not code any interventions to the *Reinforcement, Optimism* or G*oals* domains which could either be because they did not exist or due to differences in how the data were coded.

The data collection technique utilised can arguably account for one limitation of the current study, since the provision of written reflective statements may have impeded the students from fully describing their feedback on the learning activity. Semi-structured interviews are recommended as the preferred data collection method since further probing

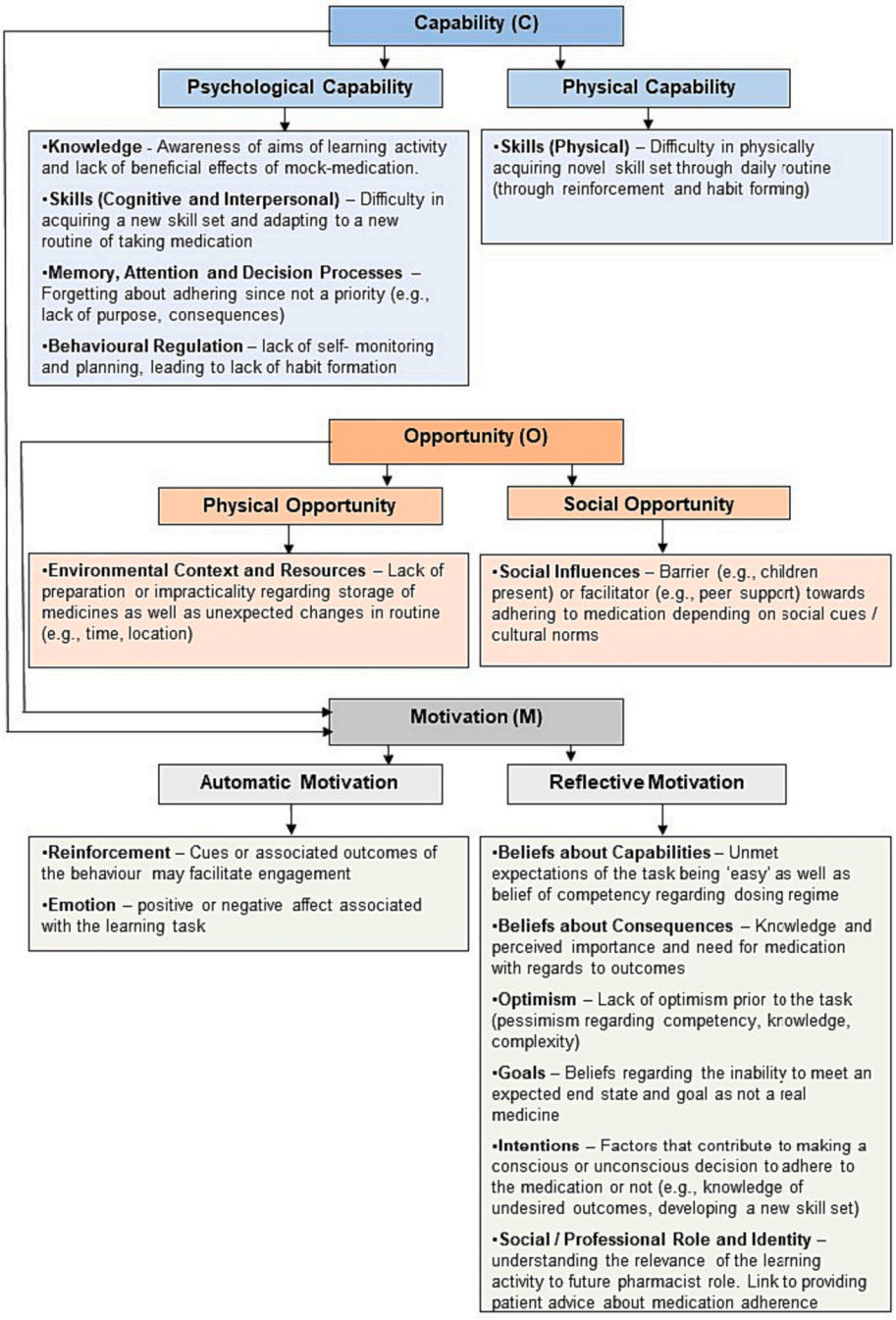

Fig. 4. Summary of the data from reflective statements for each TDF domain, mapped onto COM components of the COM-B model.

can be used to explore reasons for a specific behaviour. This was not possible in the current study, making it difficult to map to certain TDF domains and components of the COM-B model, particularly where implicit and explicit intentions were concerned. Also, students may have been more likely to attribute any failures in the task to external factors such as environmental and social factors, rather than internal factors such as their personal ability.[31] The use of multiple sources of data, such as triangulation, can also be beneficial; however, our findings suggests that written data alone can be used successfully for coding and subsequent theoretical framework analysis, which was particularly efficient for capturing data from large numbers of participants and multiple study sites.

We need to note that despite its usefulness, we do not actually know the extent to which the activity was successful in changing students' capability or motivation for addressing medication adherence issues in practise. The student cohort size in one university was much smaller than the other two, however, the findings were similar across all study sites, with respect to the range and mean number of TDF domains utilised. The fact that students knew that this was a 'mock' medicine might have implications for how they completed the task. If the task had been presented as a real medicine (i.e., a placebo formulation) more barriers and facilitators to medication adherence might have been experienced and reported. Furthermore, only taking the medication for one-week does not expose students to the challenges of taking medicines long-term, only the initiation and implementation phase described in Vrijens and colleagues' taxonomy.[39] The mock-medication used for this study was based on the use of confectionary, and as such, it is important that this does not convey the wrong message about the nature of

medications, especially for those students who may live with children.

4.2. Implications for pharmacy practice and future work

Unni and Farris demonstrated that the determinants of non-adherence varied for different medications and suggested that the ability to identify the myriad of determinants may help health professionals develop successful medication adherence interventions.[40] It could be argued that pharmacy professionals do not have sufficient understanding of the full range of determinants for medication non-adherence to identify the appropriate reason (or make the correct behavioural diagnosis). In their literature review, Allemann et al.[38] matched intervention components and patient determinants of non-adherence according to the TDF domains, illustrating how application of the TDF can provide insight into both the determinants of non-adherence and how these might be addressed by adherence interventions. Phillips et al.[41] showed that health professionals found the TDF a useful framework to support both the design and evaluation of interventions. The synthesis of several psychological theories was seen as a particular strength of the TDF, enabling a broader perspective of potential barriers and facilitators to behaviour change. However, some found the operationalisation of the TDF domains challenging, suggesting that further training would maximise the potential of this tool for clinical practice.

To prepare pharmacy students for future professional roles, an effective programme of learning must be introduced at undergraduate and post-graduate levels. The current study shows that mapping student reflections to the COM-B and TDF was applied successfully to explain different levels of medication adherence. This is encouraging, since the development of teaching methods that illustrate the relevance of psychological models to pharmacy practice has been found to be challenging.[42] This novel approach could also be applied to teaching behaviour change to other lifestyle-related behaviours where pharmacists have a role in public health interventions.[42] This learning activity could also be useful for medical students and other healthcare professions involved in the medicines management process.

Students in this study were not involved in the mapping of the reflective statements to the psychological frameworks. It is recommended that; future students are asked to map their own reflective statements plus gain an insight from the feedback provided by others (across the whole student cohort) to the COM-B and TDF to gain experience of applying these frameworks.

To date, this mapping exercise has only focused on the reasons for non-adherence, not how to develop solutions to address non-adherence problems. In order to contextualise our data and draw suggestions for the design of interventions in practice, the reflective statements were also mapped onto the Behaviour Change Wheel (BCW)[15] (Appendix 5). Taking this a step further, the process of mapping the reasons for non-adherence to the BCW could also be undertaken by the students to identify where appropriate solutions might lie. The Behaviour Change Techniques (BCT) taxonomy could then be used to identify specific interventions, based on their 'diagnoses' to match to the right techniques (or medication support). A similar process was adopted in an intervention using an avatar 'relational agent' to address medication adherence[43] and helps practitioners to move away from a 'one-size-fits-all approach'.[44] This recommendation is also supported by a recent 'Call for Action' for upskilling all pharmacists and pharmacy students on the use of BCTs in their everyday practice.[45]

Educational support to address behaviour change cannot be delivered in isolation to the development of effective communication or consultation skills by pharmacy practitioners. A recent national survey of communication skills training in Schools of Pharmacy in the UK found that although newer graduates had received more communication training compared to older graduates, they felt ill prepared for conducting consultations relating to behaviour change.[46] The authors rightly recommend further structured courses in communication skills, behaviour change techniques and further training in motivational interviewing (MI) skills. However, we propose that the pharmacy professional must also understand their own behaviour before learning how to use behaviour change techniques with patients.

4.3. Further research

This paper reports the secondary analysis of the mock medicines learning activity with successful outcomes highlighting how student behaviours map against all domains of the COM-B and the TDF. The next phase is to employ students to complete the mapping exercise themselves, increasing their understanding of how to develop patient-tailored interventions and hence supporting workforce development. A pilot of this has already been incorporated as an educational activity in another UK university with healthcare students,[47] and there are plans to evaluate these student-developed interventions as well as their experiences of using the theoretical frameworks.

4.4. Conclusion

This is the first study to utilise both COM-B and TDF frameworks to analyse medication adherence data generated within a pharmacy education context. Mapping showed that the mock medicine learning activity has the potential to expose student cohorts to the full range of experiences and issues faced by patients when prescribed a short course of medication. Future work will comprise the students themselves being involved in the mapping of these data as part of an additional learning activity to familiarise themselves with these psychological constructs, which can be applied to several different areas of pharmaceutical care. Gaining hands-on experience of psychological frameworks such as the COM—B, TDF, BCW and BCTs, may lead to more effective medicines adherence interventions by pharmacy practitioners across different settings and countries. Preparing future pharmacists in this way will ensure that the profession have maximal impact on supporting medication adherence, thus improving patient care, disease prevention and health outcomes.

Declaration of Competing Interest

The authors have no competing interests to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rcsop.2023.100393.

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