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Decomposition and recomposition in teacher education

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Breaking down sequences of teaching into constituent practices is thought to make learning to teach more manageable. However, it also divorces teaching practices from context, which risks leaving teachers unsure as to when or why to use a specific practice. Theorists have suggested that decomposing authentic sequences of teaching into their constituent parts and then recomposing them in new, meaningful sequences combines the benefits of both manageability and contextualisation. Using a classroom simulator experiment, we compared input from a teacher educator using decomposed and then recomposed sequences of teaching practice, against input that focused on whole, continuous sequences of teaching. We found that decomposition-then-recomposition was superior to a more holistic approach, and helped novice teachers adaptively transfer their teaching practices to a novel context. The findings are consistent with the idea that recomposition is complementary to decomposition, which has implications for the design of early career teacher development..

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Disclaimer

Highlights

- Learning to teach is demanding. Teacher educators therefore often break down ('decompose') teaching into its constituent parts.
- However, decomposition risks decontextualising teaching practice, leaving teachers unsure as to when or why to use certain teaching techniques.
- Theorists have suggested that recomposition (or recombination) can guard against the risk of decontextualisation by helping teachers to understand when and why to draw on a given technique. We provide the first ever test of this claim, using a classroom simulator experiment.
- Results suggest that recomposition does indeed help teachers to flexibly transfer what they have learned to novel classroom scenarios.
- Teacher educators can use recomposition to help ensure that training makes a difference in the classroom.

Why does this matter?

For training to result in improved teaching, we need to support teachers to transfer what they have learned back into the classroom. This paper provides evidence that recomposition can help achieve this important goal.

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Breaking down sequences of teaching into constituent practices is thought to make learning to teach more manageable. However, it also divorces teaching practices from context, which risks leaving teachers unsure as to when or why to use a specific practice. Theorists have suggested that decomposing authentic sequences of teaching into their constituent parts and then recomposing them in new, meaningful sequences combines the benefits of both manageability and contextualisation. Using a classroom simulator experiment, we compared input from a teacher educator using decomposed and then recomposed sequences of teaching practice, against input that focused on whole, continuous sequences of teaching. We found that decomposition-then-recomposition was superior to a more holistic approach, and helped novice teachers adaptively transfer their teaching practices to a novel context. The findings are consistent with the idea that recomposition is complementary to decomposition, which has implications for the design of early career teacher development.

Keywords: decomposition, recomposition, transfer, teacher education

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In an influential 2016 paper, Kennedy outlined a first order problem faced by all teacher educators. Teaching is a complex and multi-faceted task. Yet, to be manageable, preparation programmes must teach novices about one part of teaching at a time. This requires teacher educators to "partition the fluid practice of teaching so that they [can] articulate its constituent parts, define the specific bodies of knowledge that are relevant to teaching practice, or define the practices that comprise... good teaching" (Kennedy, 2016, p. 6). However, while there have been several attempts by teacher educators and researchers to parse the practice of teaching, no clear consensus has emerged on how best to do this. Kennedy attributes this to two challenges.

The first relates to finding the right grain size at which to make the partitions. If the grains are too small, then the list would become unmanageably long and "crowded with minutiae" (Kennedy, 2016, p. 6). For example, the Commonwealth Teacher Training Study partitioned teaching into over 1,000 discrete practices, divided into seven broad categories (Charters & Waples, 1929). By contrast, if the grain size is too large then novice teachers may fail to notice the important or relevant aspects of practice. For example, one academic theory of effective teaching contains just three categories: cognitive activation, classroom management, and pupil support (Wisniewski et al., 2020). This challenge is compounded by the fact that teacher educators will sometimes want different grain sizes, depending on which aspect of practice they want novice teachers to focus on.

The second challenge relates to decontextualising practice by separating it from the flow of authentic classroom teaching. This risks obscuring the role that a certain practice plays in a wider sequence. In Kennedy's words: "When we define teaching by the visible practices we see, without attending to the role these practices have in the overall lesson, novices are likely to use their newly acquired practices at the wrong times, in the wrong places, or for the wrong reason" (Kennedy, 2016, p. 6). In short, novice (early-career) teachers may be unable to adaptively transfer what they have learned into their classrooms, rendering the learning inert.

In a paper published around the same time as Kennedy's, Janssen et al. (2015) provide a very different conceptualisation of teaching practice as having a hierarchical modular structure. Hierarchical here means that any sequence of practice can be decomposed into a set of constituent parts. For example, checking for understanding could be decomposed into asking a question, collecting answers, and identifying misconceptions. Each of these parts can in turn be decomposed further into a set of constituent parts. As well as being hierarchical, Janssen et al. (2015) theorise teaching practice to be modular, in that the parts can be flexibly combined (or recomposed) into novel sequences at levels further up the hierarchy.

Janssen et al.'s conceptualisation suggests a way around the two challenges identified by Kennedy. The hierarchical structure allows teacher educators to sidestep the grain size problem by avoiding the need to commit to any one particular division. Teacher educators can instead choose any sequence of interest, and then decompose it to whatever level suits their purposes. Modularity allows teacher educators to guard against decontextualisation through recombining the constituent practices into novel sequences. For example, asking questions and collecting answers could be used as part of a retrieval practice exercise. Recomposing constituent practices in this way gives teacher educators a valuable opportunity to clarify how novice teachers might employ these practices at the right time, in the right place, and for the right reasons.

While this theory is compelling, it has yet to be subjected to empirical test. There is some small-scale evidence from one study that decomposition is correlated with teachers' acquisition of new teaching skills (Kavanagh et al., 2023). However, the study was not intended to provide a causal test of the theory behind decomposition and recomposition. Mancenido et al. (2023) provide a rare experimental test of the efficacy of practice-based teacher education, which incorporates decomposition. However, all three arms of the experiment included some degree of decomposition. The present research therefore provides the first causal test of the theory that decomposing and then recomposing practice is more effective than non-decomposed approaches in helping novice teachers acquire and transfer new skills. The findings will therefore be directly relevant to discussions about how best to design early career teacher education and training.

Theory and research questions

Decomposition

Decomposition refers to breaking down a sequence of teaching practice into constituent parts (Grossman et al., 2009). Consider, for example, a simple and frequently occurring classroom sequence in which a teacher is managing a transition from one classroom activity to another. This can be decomposed into a set of constituent practices such as gaining pupils' attention, signalling the end of the previous task, introducing the new task, and setting pupils to work on the new task. Within this, gaining pupils' attention is itself a sequence, which can be decomposed into constituent practices, such as asking pupils to look up, correcting pupils who continue with the previous task, and so on. Decomposition is theorised to help teachers improve their practice in two ways (Ball & Forzani, 2009; Grossman et al., 2009). First, it allows teacher educators to more precisely draw novice teachers' attention to important aspects of practice. For example, if a novice teacher is observing a teacher educator taking a class through a transition, then there is a risk that the novice teacher focuses on the content of the new task, to the exclusion of the other constituent practices. By contrast, decomposing the transition enables a teacher educator to pick out the specific practices on which they wish the novice teacher to focus. In short, decomposition is thought to improve the impact of modelling by disambiguating it.

The second way in which decomposition is thought to help teachers improve their practice is through making rehearsal and feedback more manageable. With decomposed rehearsal and feedback, a novice teacher is required to keep in mind 1) the focal practice, 2) the principles or theory underpinning the focal practice, 3) what they did during the rehearsal, 4) the feedback they are given on how to improve. This is already quite demanding for a novice teacher. However, without decomposition, the cognitive demands would likely be even higher. For example, consider a teacher educator observing a novice teacher giving a complete lesson and providing feedback on multiple aspects of practice afterwards. Meaningfully processing the feedback now requires the novice teacher to have noticed and then recalled all the relevant parts of the lesson, and then keep in mind the four types of information listed above for each of the multiple aspects of practice on which the teacher educator gives feedback.

Alongside these two advantages, we might also be concerned that decomposition has some disadvantages. Indeed, Janssen et al. (2015) suggest that there may be motivational drawbacks, in that working on discrete sets of practices lacks authenticity. By contrast, working on longer sequences, which more closely resemble authentic classroom teaching, may be perceived as more valuable by novice teachers. Motivation is known to be an important determinant of whether and how teachers adapt their practice following professional development (Emo, 2015; Kennedy, 2016; Sims, Fletcher-Wood, O'Mara-Eves, et al., 2023). In particular, expectancy-value theory suggests that teachers' perceptions about the value of putting the professional development into practice will influence the extent to which they subsequently adapt their teaching.

Based on the above theory, we set out to answer the following set of (pre-registered) research questions (RQs):

- RQ1: Does decomposition overall help or hinder novice teachers' development of new teaching skills1?
- RQ1a: Is any positive effect of decomposition on skill development mediated by trainees' cognitive load during the professional development (PD)?
- RQ1b: Is any negative effect of decomposition on skill development mediated by trainees' perceptions of the value of the PD?

Recomposition

Recomposition refers to a teacher recombining a sequence of teaching practices into novel, meaningful sequences (Janssen et al., 2015). For example, Janssen et al. (2014) give the example of a practical/lab lesson in science, which can be decomposed into the following sequence: explaining the theory to the class, formulating a question for them to answer, setting out the materials and method, supporting them with data collection and analysis, and then facilitating explanation of the results. Janssen et al. (2014) explain that student teachers tend to conduct a practical science lesson in this order but also show how teacher educators can support them to recompose these constituent practices into more of an 'open inquiry' sequence. This involves beginning with the question, followed by materials, (tentative) explanation, method, data collection and analysis, further explanation and then theory. The two sequences involve the student teacher using similar constituent teaching practices but in a different order, and to achieve a slightly different goal.

Decomposition alone is thought to risk novice teachers developing a repertoire of practices but being unable to draw on them at the right moment, for the right reason. This is due to the practices being decoupled from a wider sequence of teaching. For example, teacher educators might ask their student teachers to focus on the use of eye contact to correct off-task pupil behaviour. The novice teacher might end up using it inappropriately if they have not experienced it in the context of a whole classroom scenario. For example, they might use it to deal with persistent or serious misbehaviour while it is more appropriate to deal with low-level disruption. For novice teachers to grasp the difference, they need to understand that eye contact is useful insofar as it redirects off-task behaviour quickly, without causing further disruption for other pupils (Colvin & Scott, 2014; Horner et al., 1990). In the case of serious and persistent misbehaviour, however, the class is likely to already be disrupted, making eye contact inappropriate.

Recomposing the constituent practices allows the teacher educator to contextualise the practice in a wider sequence, thus making more salient the conditions under which it is useful. For example, the teacher educator could model and then ask the novice teacher to rehearse the complete new sequence. This provides an opportunity for the teacher educator to explain why a particular practice was appropriate at a particular point in the sequence, using concrete examples from their model. For example: "Did you notice how Jamie was clearly not reading but was not disrupting the others? That allowed me to use eye contact to get him back on task, without disrupting the rest of the class." This would arguably be much harder for the novice teacher to grasp if the constituent practices were being modelled and rehearsed in isolation, with the teacher educator having to rely on more abstract explanations for when eye contact would (or would not) be helpful. Thus, recomposition is thought to give novice teachers a deeper understanding of the constituent practices, making it highly complementary to decomposition (Janssen et al., 2015).

Based on the above theory, we also set out to answer the following (pre-registered) research question:

- RQ2: Is decomposed-then-recomposed input from the teacher educator more effective than the equivalent amount of non-decomposed input for helping novice teachers' adaptive transfer of new teaching skills?

Current study

To address these research questions, we conducted a two-arm randomised experiment using a classroom simulator. We tested whether novice teachers developed a set of teaching practices better or worse when they received training with decomposed followed by recomposed input from a teacher educator, compared to non-decomposed input only. Novice teachers took part in three classroom simulator exercises in which they were tasked with managing pupil behaviour. Critically, the third simulator exercise involved novel sequences of pupil behaviour, allowing us to compare the effects of non-decomposed versus decomposed-then-recomposed input on the adaptive transfer of new teaching skills.

Methods

The study was pre-registered with the Registry of Efficacy and Effectiveness Studies on 28 July 2023 and updated on 9 August 2023, due to lower-than-expected initial recruitment (Registry ID: 10680.1v2 https://sreereg.icpsr.umich.edu/sreereg/subEntry/20360/pdf?action=view). Both pre-registrations were published before data collection for the simulator task began on 10 August 2023. Pre-registrations, as well as all analyses, code and materials are openly available at https://osf.io/dwkb6 . Full ethical approval was granted from UCL IOE Research Ethics Committee on 28 June 2023, with registration number Z6364106/2023/06/54. A pre-print (working paper) version of this paper can be found at Banks et al. (2024).

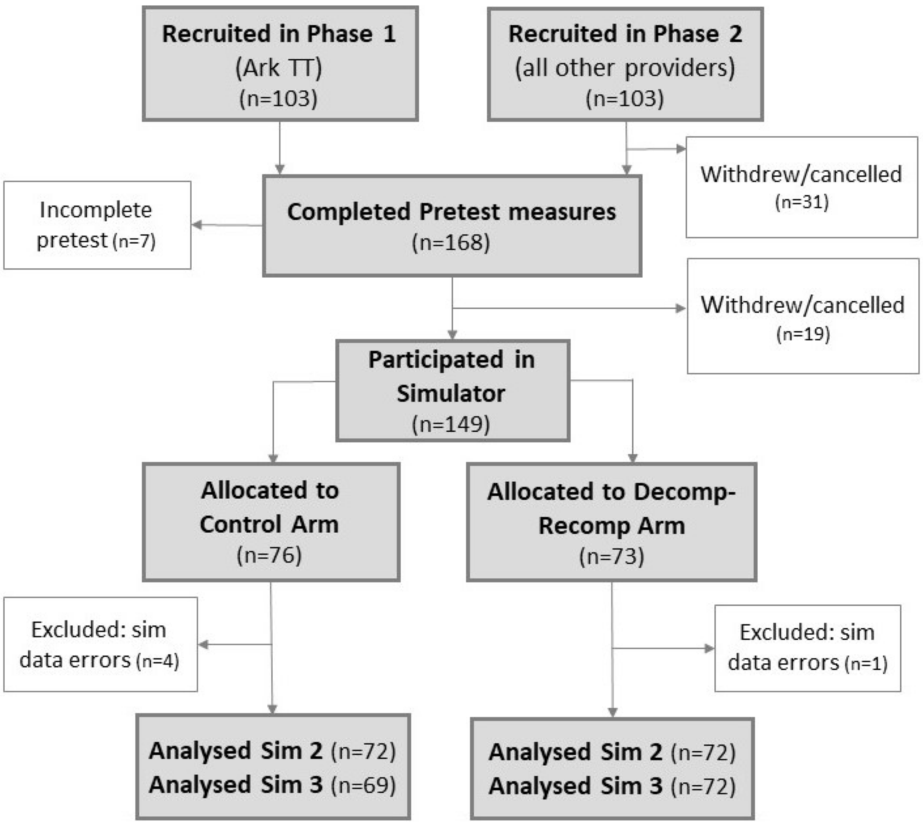
Participants

All participants were recruited from postgraduate initial teacher training programmes in England between August and October 2023. Participants gave informed consent in an online survey during their pretest data collection and were given a £25 Amazon voucher on completion of the pre-test survey and simulator session. Participants were randomly assigned to the two experimental arms by using a custom R script to create N = 200 arm allocations. Participants were allocated when they completed the pre-test data (see Procedure) and could not anticipate the experimental arm they were allocated to before taking part.

The flow of participants through the study is summarised in Figure 1. A quarter of participants originally recruited dropped out before taking part in the simulator task. We also excluded five participants after their simulator session due to incomplete data: one due to participant ill health, one due to technical issues with the software, and three due to not fully completing the simulator task. Our final sample was therefore 144 (N = 72 in each arm). Of these, three participants were excluded from Sim 3 analyses as they did not fully complete this part of the simulator task. Two of the 144 participants also had missing data for the working memory task: one due to technical issues and one due to not following instructions correctly.

Figure 1

Consort diagram for study recruitment, participation and analysis



Note. *Sim = simulator exercise.*

Table 1
Demographic breakdown of participants by arm

	Control Arm	Decomp-Recomp Arm
No. of participants	72	72
Gender		
Female	53	55
Male	19	16
Other	0	1
Ethnicity		
Asian	19	7
Black	8	8
Mixed	6	5
Other	3	4
White	36	48
Education Level		
Undergraduate	45	45
Postgraduate	27	27
Experience as teaching assistant		
Yes	27	34
No	45	38
School phase		
Primary	20	15
Secondary	51	57
Unknown	1	0
Recruitment phase		
Phase 1	40	35
Phase 2	32	37
Training provider		
Ark	40	35
UCL	26	28
Age		
M(*SD*) years	30.14 8.94)	29.79 (9.16)

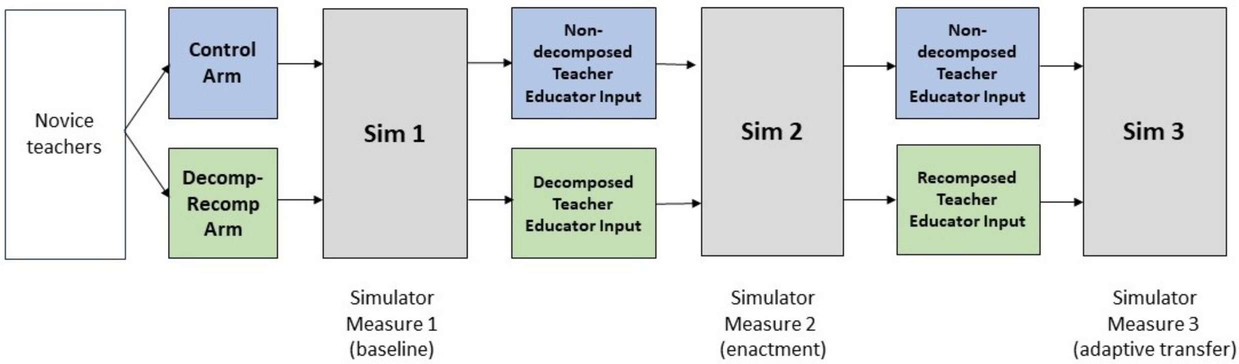
Note. We used Chi-squared and independent sample t-tests to examine group differences on all demographic variables, none of which were significant (all ps >.05).

Study design

Figure 2 provides a high-level overview of the study. All participants took part in the same three classroom simulator exercises (Sim 1, 2 and 3). Sim 1 and 2 were identical to each other, which allowed us to directly compare changes in participants' behaviour management skill. Sim 3 was novel, which allowed us to measure how well participants could adaptively transfer what they had learned to a different scenario. After Sim 1, and again after Sim 2, all participants received input from a teacher educator. The way in which the teacher educator delivered this input differed depending on the experimental arm to which the participant was allocated: Control (non-decomposed) or Decomp-Recomp; see 'Teacher Educator Input' below. The entire session, including the three simulator exercises and input from the teacher educator, took approximately 30 minutes.

Figure 2

High-level overview of study design



Note. Sim = simulator exercise. Decomp = decomposition. Recomp = recomposition.

Teacher Educator Input

The teacher educator input between the simulator sessions was provided by one of two experienced teacher educators, following a script. To maximise consistency, the two teacher educators practised the process together prior to piloting, observed each other during piloting, and observed each other during the first few sessions of data collection. They then reviewed videos of these sessions together, compared their approaches, and jointly decided how to eliminate differences in practice.

The teacher educators' input between the simulator sessions took approximately five minutes, and comprised four parts: feedback, explanation, modelling and practice (see Appendix A for detailed scripts). This was designed to represent the process novice teachers would commonly experience after an observation of teaching. First, the teacher educator provided scripted feedback and explanation to participants based on their performance in the preceding simulator task, and specifically whether they used the three constituent practices correctly (see Constituent teaching practices below). If a participant used a practice correctly, the teacher educator's feedback acknowledged this and explained what was involved in using the practice correctly. If a participant did not use a practice correctly (or at all), the teacher educator suggested that they could have used the practice and explained how to use it correctly. Critically, all participants received the same explanation of how to carry out the constituent practices correctly and why (in theory) they are valuable; this allowed us to control the amount of information participants received about the practices across the different arms. Second, the teacher educator modelled the constituent practices to the participant within the simulator. Third, the teacher educator gave the participants a chance to practise for themselves, also within the simulator. All participants experienced the same amount of feedback, explanation, modelling and practice. However, the exact way in which the teacher educator delivered this differed depending on the experimental arm to which the participant had been allocated (see Table 2 for a summary).

Arm 1: In this arm, input from the teacher educator did not involve any decomposition (or recomposition), and modelling and practice always involved a full sequence of the three constituent practices. The teacher educator began by giving feedback and explanation on the complete sequence of teaching from the prior simulator attempt. This included information about the timing of the practices in the sequence (i.e., why they were appropriate at certain points), as well as how to use them and why they were valuable. The teacher educator then modelled the constituent practices in a complete sequence, and the novice teacher also practised them in a complete sequence. This approach was devoid of decomposition in three ways. First, the teacher educator provided feedback and explanation on all three constituent practices in one go, and without naming them individually. Second, the teacher educator explained the practices in relation to the overall sequence, explaining when they were used and why. Third, modelling and practice was done on all three constituent practices in a single continuous sequence, rather than breaking up the model and practice into three parts. Input from the teacher educator followed the same format after Sim 2 as it did after Sim 1, and feedback, explanation, modelling and practice were always done on the same scenario (with the constituent practices in the same order) to avoid any recomposition.

Arm 2: In this arm, participants received decomposed input from the teacher educator after Sim 1, and recomposed input after Sim 2. For decomposed input, the sequence of teaching was split into the three constituent practices. The teacher educator gave feedback, explanation, modelling and practice on the first constituent practice, then repeated this for the second constituent practice, and again for the third constituent practice. This involved decomposition in three ways. First, the teacher educator provided feedback and explanation for each constituent practice separately, giving each of them a name. Second, the teacher educator did not explain the practices in relation to the overall sequence. That is, participants did not receive any explanation about why the practices were used at a particular point in the sequence. Third, the teacher educator modelled the three constituent practices separately, rather than in a continuous sequence, and participants subsequently practiced them separately. For recomposed input, the constituent practices were recomposed into a novel sequence in a different order. The teacher educator first provided feedback and explanation for the three practices all in one go, using the same explanations as for the decomposed input (i.e., naming the practices and without referring to the overall sequence). They then provided participants with a novel teaching scenario (see Appendix A). Following a script, they explained how they would use the three constituent practices to address pupil behaviour in the new scenario, explaining when they would use them in the sequence and why. The practices were also individually named. Critically, the scenario involved pupil behaviour not previously experienced in the simulator task and required the constituent practices to be used in a different order. The teacher educator then used the simulator to model how they would use the constituent practices in the novel sequence, and participants practiced the novel sequence, also using the simulator.

Table 2

Definitions of control (non-decomposed), decomposed and recomposed teacher educator input

	Control (non-decomposed)	**Decomposed**	**Recomposed**
Feedback, modelling, practice, and explanation of how and why (in theory) to use the practices	On a continuous sequence	On each practice in turn	On a continuous sequence
Explanation of when to use the practice	✓		✓
Makes use of a novel sequence			✓
Constituent practices named		✓	✓

Constituent teaching practices

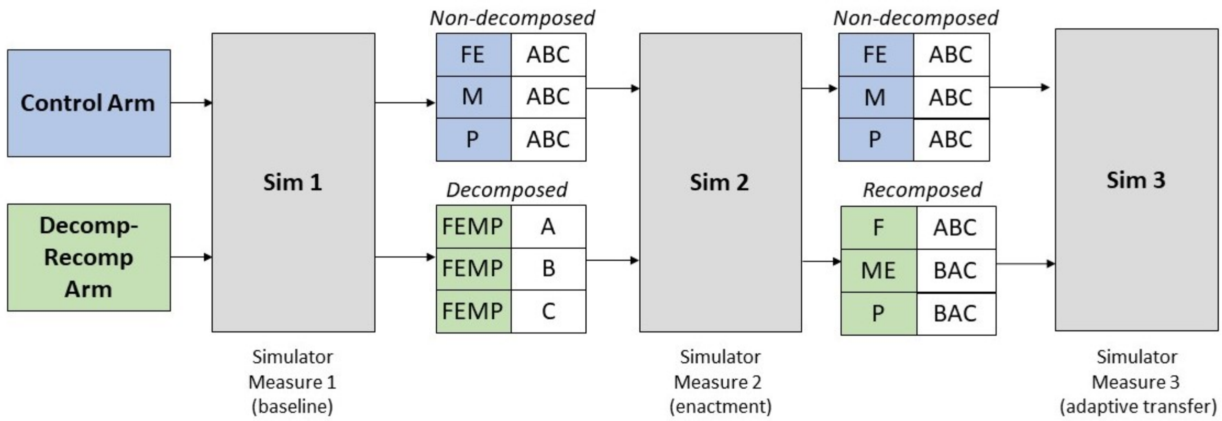
Our teacher educators focused their input on three behaviour management practices drawn from the ATT curriculum, which focuses on positive behaviour management (PBM). PBM prioritises the explicit teaching and reinforcement of good behaviour (Horner et al., 1990). The aim is to prevent bad behaviour occurring, which directly reduces pupil time off task. PBM is also thought to have second order benefits in that teachers have to spend less time correcting bad behaviour, including dealing with ‘secondary incidents’ in which pupils then dispute or protest the teachers’ corrections (Colvin & Scott, 2014). This further reduces pupil time off task. A small empirical literature suggests that PBM is a promising approach to managing pupils’ behaviour (Närhi et al., 2015, 2017; Sutherland et al., 2000). The three behaviour management practices were as follows.

Constituent practice A: anonymous correction. This involves the teacher stating what the pupils should be doing (not what they shouldn’t be doing) and emphasising that the misbehaving pupils are in the minority, without naming them. For example, “I need two more people to start writing”. In line with the wider rationale for PBM, there are two reasons why (in theory) anonymous corrections help minimise off-task behaviour. First, they help reinforce norms of good behaviour through focusing on the desired behaviour and emphasising that the pupils misbehaving are in the minority. Second, they help reduce secondary behaviour incidents by not directly naming the pupils that are misbehaving, which reduces the likelihood of the pupil protesting. The underpinning rationale for Anonymous Corrections suggests this practice should be used when off-task behaviour is low-level, when a small number of pupils are off task but before a (potentially more disruptive) sanction is given.

Constituent practice B: sanction. In our study, this involved the teacher giving the pupil a demerit, following the format: name, demerit, instruction. For example, “Carlos, that’s a demerit, we’re in silence”. In theory, sanctions of this kind help minimise off-task behaviour because they are brief, which minimises the disruption caused to other pupils. Additionally, they end by reiterating what the pupil should be doing, which further reinforces norms of good behaviour. The underpinning rationale for sanctions suggests that this practice should be used after a (less disruptive) correction has been tried but the focal misbehaviour has persisted, or if there is serious misbehaviour which is already causing widespread disruption and therefore needs to be quickly stopped.

Constituent practice C: narrate the positive. This involves the teacher describing the good behaviour they are seeing in the classroom and naming the pupils who are doing it. For example, “Mina has her pen down and her eyes on me, thank you Mina”. This helps reduce time off task by reinforcing norms of good behaviour via role model pupils. The underpinning rationale for narrating the positive suggests that this practice should be used when pupils are on task and the teacher is looking to prevent pupils going off task. If any pupils were off task, then (in theory) it would be more effective to use a correction which alerts the pupils to being out of line with both their peers and the teachers’ expectations. Decomposition and recomposition: effects on novice teachers’ enactment and transfer of behaviour management practices Ambition Institute 2024 18 Figure 3 below provides a more detailed overview of the study design, illustrating exactly how the two arms differ from each other. This incorporates the feedback (F), explanation (E), modelling (M), and practice (P) provided by the teacher educator, as well as the three constituent practices: anonymous correction (A), sanction (B), and narrate the positive (C).

Figure 3
Detailed overview of study design



Note. *F = feedback; E = explanation; M = modelling; P = practice. Constituent practices: A = anonymous correction; B = sanction; C = narrate the positive. Other acronyms as in Figure 2. The switch to BAC in recomposed practice implies that a novel scenario was used.*

Classroom simulator

We used a classroom simulator for this study because it allowed us to exercise a high level of experimental control over the way in which the avatar pupils acted and then reacted to the participating teachers. We used the Mursion simulator environment (Cohen et al., 2020; Ferguson & Sutphin, 2022), implemented within a Zoom online video conference call (see Figure 4 and demo video in supplementals). Mursion is a mixed reality environment in which pupil avatars are controlled by both a human simulation specialist and the underlying software. The classroom features five pupils, each with a name badge on the desk in front of them. The avatar pupils can, individually or as a group, be made to perform a range of actions including putting up their hands, talking as a group, or writing.

Figure 4

Scene from the classroom simulator featuring five avatar pupils

Simulator task and scenarios

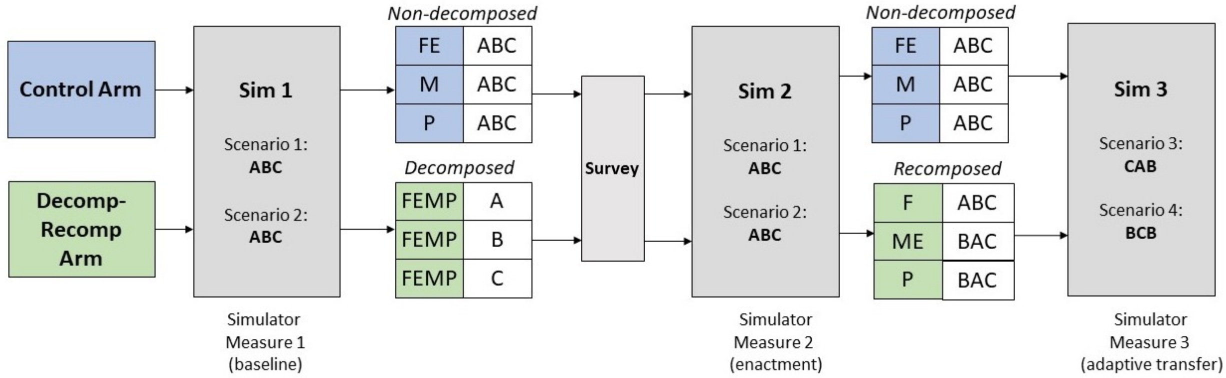
We developed four classroom scenarios which lasted approximately two minutes each. These focussed on a frequently occurring behaviour management challenge faced by all teachers, irrespective of subject and phase: keeping pupils on task as they transition between lesson activities. At the beginning of each scenario, the teacher educator briefly explained the scenario to participants, gave them a starting script (see Appendix A), and instructed them to then respond to pupil behaviour. Scenarios 1 and 2 featured one after the other in both Sim 1 and Sim 2, while scenarios 3 and 4 occurred one after the other in Sim 3 only (see Figure 5), allowing us to measure participants' transfer to new contexts.

In all scenarios, pupils misbehaved and participants were required to manage this behaviour. If the participants used the appropriate practice at the appropriate time, the pupils would comply. If they used an inappropriate practice, then the pupil would either ignore the teacher or argue back. Pupils behaved in a different way depending on the scenario: this meant that participants needed to use the constituent practices in a particular order to minimise time off task (see Figure 5). For example, in Scenarios 1 and 2, several pupils did not follow the initial instruction, and one pupil persistently ignored it. For these scenarios, the practices were best used in the order ABC.

Scenarios 3 and 4 involved different types of (mis)behaviour: pupils used their phones, talked to each other or simply stopped writing during a silent writing task. The scenarios also required participants to use the constituent practices in a different order, for example, they were best used in the order BCA in Scenario 3. The novel pupil behaviour and different order for the constituent practices allowed us to measure adaptive transfer in Sim 3. Figure 5 provides a full overview of the study design.

Figure 5

Full overview of study design



Note. Acronyms as in Figure 2 and 3.

Measures

Participant skill. To measure how well participants carried out the three constituent practices, we developed a scoring rubric for each behaviour management practice (see Video Coding Schemes, Appendix F). This assessed 1) whether the participant used the practice at the appropriate time, and 2) whether they used it correctly. To make scoring as objective as possible, we broke down each practice into its core components (for example, when giving a sanction, a novice teacher had to name the pupil, give them a demerit, and provide an instruction of what to do). We also defined the appropriate type of pupil behaviour to warrant the intervention (for example, a sanction should be used whenever a pupil displayed persistent or major off-task behaviour). Each practice could score between 2 and 0 based on whether they were fully correct, partly correct or incorrect/never attempted. In each Sim, the maximum score for participant skill was 12 (2 per practice across six practices). The summed score for each simulator formed the dependent variable in our analyses.

Time off task. In line with the rationale for PBM, we developed a measure to quantify the amount of time pupils spent off-task in each simulator scenario. We defined boundaries based on the off-task behaviour for each Sim scenario, which would indicate when the pupils were off task and when they were back on-task (see Video Coding Schemes, Appendix F). For example, we could measure when Emily was off task from the point when she started talking to Will, to when she started writing again. Time off task was then summed across each simulator task, and the total time off task per simulator (in seconds) formed the dependent measure in our analyses.

Simulator measure scoring and video coding. We scored participant skill and measured pupil time off task by coding the videos of their three simulator sessions (for full details see Appendix F). Three Research Assistants and the lead author carried out the coding and were blind to participant arm allocation throughout the process. We assessed reliability between the coders which, after a process of feedback and correction, was excellent for both simulator measures and all constituent practices (Intraclass Correlation range: .93 – .98, all ps < .001). Additional information about measures can be found in Appendix E.

Procedure

We collected participants' baseline data in an introductory call, prior to them taking part in the simulator task. Participants then joined a second call with the teacher educator and the simulator specialist, both of whom were aware of the participants' experimental arm. The teacher educator recapped the first classroom scenario and instructions and gave the participant a starting script. After participants completed the first scenario of the simulator task, the teacher educator explained the second scenario and then participants completed it. Next, all participants received input from the teacher educator according to their experiment arm and completed the survey of cognitive load and task value. They then proceeded to Sim 2 following the same procedure. Immediately after, they again received input from the teacher educator according to their arm. Participants then followed the same procedure as before for Sim 3.

Statistical analysis

Research questions 1 and 2 were tested using linear regression, with skill and time off task in Sim 2 (RQ1) and Sim 3 (RQ2) as dependent variables. We used the following equation for all regression analyses:

$$Y_i^2 = \alpha + \beta_1 ControlVsDecompRecomp_i + \beta_2 Y_i^1 + \beta_3 X_i + \beta_4 Z_i + \varepsilon_i$$

Where:

- i indexes individual participants in the experiment
- Y_i^2 is the relevant outcome measure (Skill or Time off Task captured in Sim 2 or 3) standardised to have mean 0 and standard deviation 1
- $ControlVsDecompRecomp_i$ is a dummy variable (0 = individuals allocated to *control* arm, 1 = individuals allocated to *Decomp-Recomp* arm)
- Y_i^1 is the pre-test outcome measure captured in Sim 1 standardised to have mean 0 and standard deviation 1
- X_i is a vector of demographic covariates
- Z_i is a vector of psychological covariates

- β_1 captures the average effect of receiving decomposed (RQ1), or decomposed followed by recomposed (RQ2) teacher educator input, relative to receiving non-decomposed

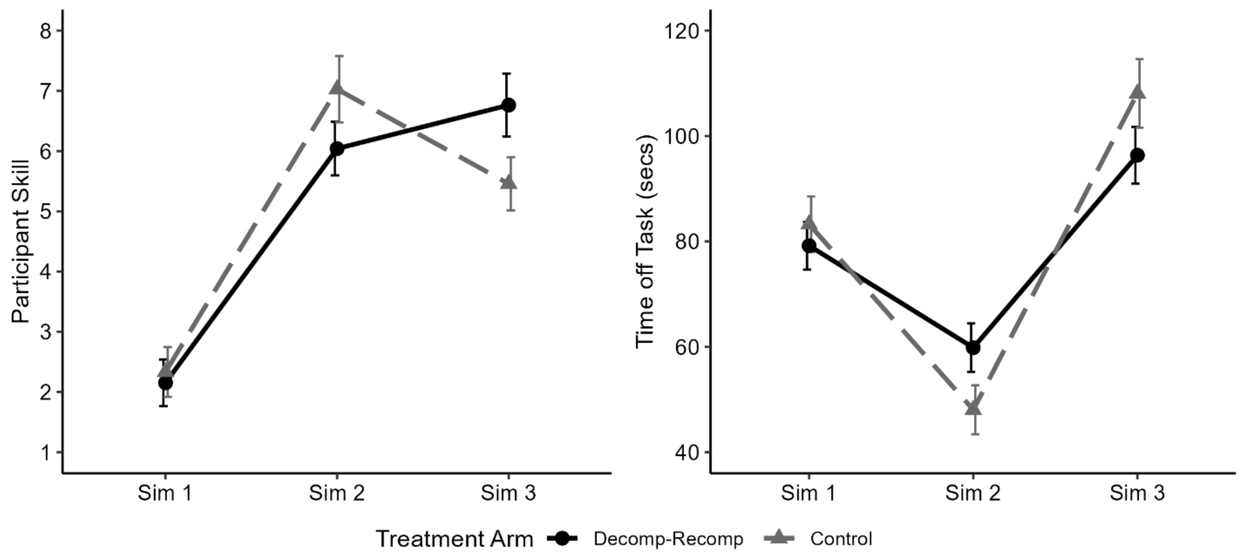
To answer RQ1a and RQ1b, we conducted two path analyses (see Figure 7) with either skill or time off task in Sim 2 as the dependent variable, experiment arm as the main predictor variable of interest, and cognitive load and task value as mediator variables.

Results

Participants in each experiment arm performed equally well in Sim 1 (see Figure 6), with very similar mean skill (t(142) = -0.62, p = .533) and time off task (t(142) = -1.15, p = .252), meaning that the two groups were well equated in baseline performance. Participants in each arm were also well equated in terms of psychological and cognitive measures (see Table 3, Appendix G).

Figure 6

Participant skill (left panel) and time off task (right) by experiment arm in the three simulator tasks



Note. *Error bars show 95% Confidence Intervals around the mean. Regression analyses indicated significant differences between the experiment arms in Sim 2 and Sim 3 for both measures (p < .05)*[1].

RQ1: Does decomposition help or hinder novice teachers' development of new teaching skills?

Participant skill. Table 4 shows the full results of the regression analyses for RQ1. Experiment arm significantly predicted participant skill in Sim 2 in both the simple model (including only Sim 1 Skill and experiment arm as predictors) and the full model (controlling for all demographic and psychological covariates; unstandardised B = -0.83, SE = 0.36, 95% CI = [-1.55; -0.12]).

Time off task. Experiment arm significantly predicted Time off Task in Sim 2 in both the simple and the full model (full model: unstandardised *B* = 11.96, *SE* = 3.52, 95% *CI* = [5.00; 18.92]). A positive coefficient indicates that pupils in the Decomp-Recomp arm spent approximately 12 seconds more time off task than pupils in the Control arm; i.e., participants managed classroom behaviour better in the control arm.

Table 4

RQ1: Regression analyses for participant Skill and pupil Time off Task in Sim 2

	Participant Skill			**Pupil Time off Task**		
	β (*SE*)	***t***	***p***	**β (*SE*)**	***t***	***p***
Simple Model:	R^2 = .15			R^2 = .12		
Sim 1	0.32 (0.08)	4.10	< .001	0.18 (0.08)	2.19	.030
Arm (Decomp-Recomp)	-0.40 (0.16)	-2.54	.012	0.61 (0.16)	3.83	< .001
Full Model:	R^2 = .24			R^2 = .19		
Sim 1	0.29 (0.08)	3.54	<.001	0.18 (0.08)	2.12	.036
Arm (Decomp-Recomp)	-0.38 (0.16)	-2.31	.023	0.58 (0.17)	3.40	<.001

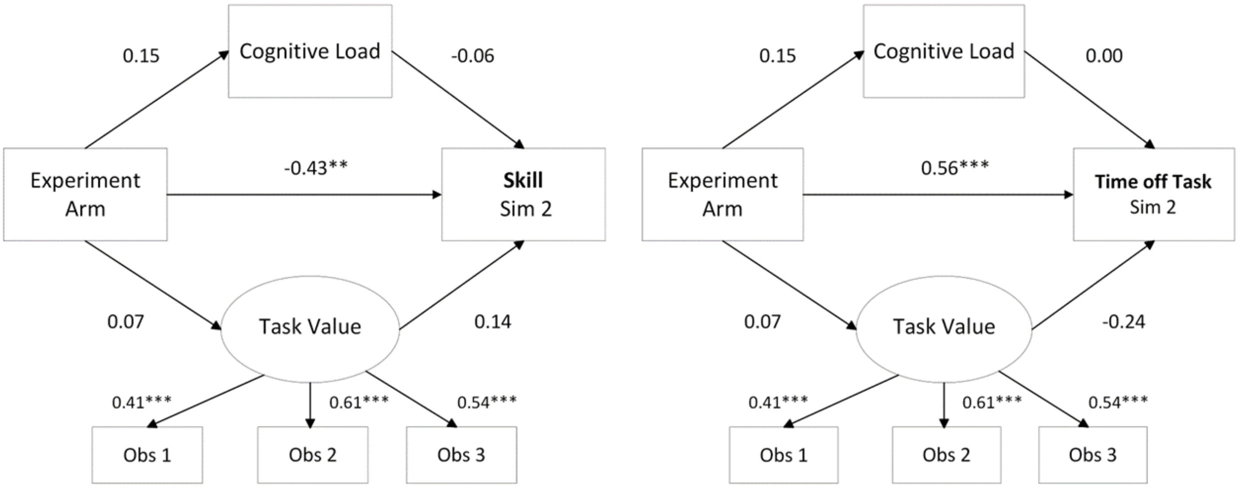
Note. All coefficients are standardised (expressed as z-scores). Full regression outputs can be found in Appendix G Table 4.

RQ1a/b: Is any positive/negative effect of decomposition on skill development mediated by novice teachers' cognitive load / perceived value of the professional development?

Figure 7 shows the path diagrams testing mediation effects of cognitive load and task value on skill and time off task in Sim 2. The three items for task value loaded significantly on the latent factor. Both models fit the data well (skill: $\chi 2$ = 4.96, p = .665, CFI = 1.00, TLI = 1.025, RMSEA = 0; time off task: $\chi 2$ = 6.24, p = .512, CFI = 1.00, TLI = 1.009, RMSEA = 0). However, no mediation effects were present in either model.

Figure 7

Path diagrams testing mediation effects of cognitive load and task value on participant skill (left) and time off task (right) in Sim 2



*Note. All paths therefore show standardised coefficients (expressed as z-scores). ** p < .01; *** p < .001. Obs 1-3 are questionnaire items.*

RQ2: Is decomposed-then-recomposed input from the teacher educator more effective than the equivalent amount of non-decomposed input for helping novice teachers' adaptive transfer of new teaching skills?

Participant skill. Table 5 shows the full results of the regression analyses for Research Question 2. Experiment arm significantly predicted participant skill in Sim 3 in the simple and full model (full model: unstandardised B = 1.08, SE = 0.35, 95% CI = [0.38;1.77]). A positive coefficient indicates that participants in the DecompRecomp arm carried out the constituent practices better than participants in the Control arm in Sim 3, by an average of 1 point.

Time off task. Experiment arm significantly predicted amount of pupil time off Ttsk in Sim 3 (full model: unstandardised B = -13.93, SE = 4.48, 95% CI = [-22.80; -5.06]). A negative coefficient indicates that pupils in the Decomp-Recomp arm spent approximately 15 seconds less time off task than in the Control arm, i.e., participants managed classroom behaviour better in the DecompRecomp arm.

Table 5

RQ2: Regression analyses for participant Skill and pupil Time off Task in Sim 3

	Participant Skill			**Pupil Time off Task**		
	β (*SE*)	***t***	***p***	**β (*SE*)**	***t***	***p***
Simple Model:	$R^2 = 0.09$			$R^2 = 0.05$		
Sim 1	-0.11 (0.08)	-1.30	.196	0.01 (0.09)	0.08	.934
Arm (Decomp-Recomp)	0.56 (0.16)	3.44	< .001	-0.42 (0.17)	-2.54	.012
Full Model:	$R^2 = 0.26$			$R^2 = 0.17$		
Sim 1	-0.14 (0.08)	-1.67	.097	-0.01 (0.09)	-0.08	.936
Arm (Decomp-Recomp)	0.49 (0.16)	3.07	.003	-0.53 (0.17)	-3.11	.002

Note: All coefficients are z-scores. Full regression outputs can be found in Appendix G Table 5.

Table 6 (Appendix H) provides a summary of the results from further sensitivity analyses. Adding any one of the methodological variables (recruitment phase, teacher educator or either type of sim errors) to the full models used in RQ1 and RQ2, did not result in a significant change in R^2.

Discussion

We set out to provide the first experimental test of combining decomposition and recomposition. We found that when it comes to enacting new teaching practices, without the need for any adaptive transfer, decomposition was in fact inferior to our non-decomposed input from a teacher educator. Contrary to the theory behind decomposition, teachers' cognitive load did not mediate the effect of decomposition on their performance in Sim 2, and there was no difference in perceived cognitive load between the two groups. This result may help to explain why decomposition did not lead to greater improvements.

Janssen et al. (2015) suggested another possible reason that decomposition may be undesirable – it is less authentic and may therefore be demotivating for teachers. However, participants' perceived value of input from the teacher educator did not mediate the improved outcomes for the Control group, and there was no significant difference in perceived value between the two groups. We therefore think it highly unlikely that the greater improvements in the Control arm were due to teachers' valuing the decomposed input less.

In comparison, our results suggest that decomposed-then-recomposed input is more effective than non-decomposed input for adaptive transfer. Indeed, for our participant skill outcome measure, the DecompRecomp group continued to improve their scores relative to their second simulator attempt, while the scores for the Control group actually declined. Since the ultimate goal of teacher education is for participants to adaptively transfer what they have learned back into their day-to-day work, we consider this adaptive transfer outcome to be more important than enactment. This finding supports the argument that recomposition helps new teachers use practices at the right time.

This pair of findings – that decomposition alone was not superior for enactment, but decomposition-then-recomposition was superior for adaptive transfer – are consistent with the theory that recomposition is the "necessary complement" to decomposition (Janssen et al., 2015, p. 139). In Janssen et al.'s (2015) modular hierarchical account, decomposition 'decouples' each constituent practice from other practices at the same hierarchical level. For example, a sanction is treated as an individual practice. It also 'decouples' constituent practices from vertical connections in the hierarchy. For example, the practices are disconnected from the overall sequence, the timings and the teaching context in which they were used. In this view, recomposition 'reconnects' the constituent practices both horizontally and vertically (Janssen et al., 2015).

Implications

The findings reported here have three implications for teacher educators. First, teacher educators should consider incorporating decomposition-and-recomposition whenever their goal is to support novice teachers to adaptively transfer what they have learned back into real classrooms. For example, recent reforms in England have made Intensive Training and Practice (ITAP) a mandatory part of initial teacher training. ITAP is explicitly structured around the "decomposition of teaching" (Department for Education [DfE], 2021) followed by "opportunities to apply the aspect of practice... in multiple contexts and practice situations" with the aim of having a "sustained impact on practice that is transferable to a range of contexts" (Department for Education [DfE], 2023, p. 5). Our findings provide support for important parts of the theory that underpins this reform.

Second, and more generally, we believe that our findings strengthen the rationale for coaching or mentoring approaches that employ cycles of classroom observation and out-of-classroom feedback, modelling and practice. Such a cyclical structure allows teacher educators to observe authentic teaching sequences in the classroom, decompose them with novice teachers outside of the classroom, and then work with novice teachers to recompose them both outside the classroom and back in real classroom situations.

Third, whenever teacher educators use decomposition, they should consider accompanying it with recomposition, since the two are likely to be complementary. For example, many practice-based teacher preparation programmes in the US are designed around careful decomposition (Grossman, 2018). However, those working within the practice-based teacher education paradigm appear to place far less emphasis on recomposition. A recent review of the literature on practice-based teacher education makes no references to recomposition, for example (Hauser & Kavanagh, 2019).

Limitations

These findings should be considered in light of the limitations of this research. Two in particular stand out. The first relates to the number of deviations from protocol we experienced in the simulator task, as detailed in Appendix F. However, we carefully documented all such deviations and conducted sensitivity analyses which suggest that these deviations did not affect our results. Second, the findings reported here rely on our specific operationalisation of decomposition and recomposition. Our definitions were based on the theory outlined by Janssen et al. (2015). However, we note that this may not always reflect existing types of 'non-decomposed' teacher education, and this should be taken kept in mind when interpreting the results.

Conclusion

The present study provides the first causal evidence that decomposition followed by recomposition can help novice teachers efficiently learn and adaptively transfer new teaching skills. Future research will need to determine exactly why and how decomposed-then-recomposed input is beneficial, and which elements of these methods are critical to achieving adaptive transfer. However, our findings support the use of decomposition and recomposition in early career teacher development.

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