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The complexity of the lesson planning task: Consequences for student teacher education

Abstract

Teacher education is supposed to prepare prospective teachers to plan their future lessons thoroughly. However, empirical findings on planning differences between inexperienced and experienced teachers and on problems of student teachers' first lesson plans indicate that teacher education does not meet this expectation. This discrepancy between expectation and reality is sometimes explained by the complexity of the planning task, the concrete characteristics of which have hardly been analyzed until now. Therefore, this article relates specific complexity dimensions to the lesson planning task, which could raise awareness of the demands placed on human cognition while learning how to plan in early teacher education.

Keywords: lesson planning, planning complexity, complexity dimensions, teacher education

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Die Komplexität der Unterrichtsplanungsaufgabe: Konsequenzen für die Ausbildung von Lehramtsstudierenden

Zusammenfassung

Die Lehramtsausbildung soll angehende Lehrkräfte darauf vorbereiten, ihren künftigen Unterricht gründlich zu planen. Empirische Befunde zu Planungsunterschieden zwischen erfahrenen und unerfahrenen Lehrkräften sowie zu Planungsproblemen von Lehramtsstudierenden deuten allerdings darauf hin, dass die tatsächlichen Leistungen der Lehramtsausbildung von dieser Erwartung abweichen. Erklärt wird diese Diskrepanz unter anderem durch die Komplexität der Planungsaufgabe, deren Kennzeichen aber bisher kaum genauer analysiert wurden. In diesem Beitrag werden deshalb konkrete Komplexitätsdimensionen auf die Unterrichtsplanungsaufgabe bezogen, was die Lehramtsausbildung für Anforderungen insbesondere an die menschlichen Kognitionen beim Lernen von Unterrichtsplanung sensibilisieren könnte.

Schlüsselwörter: Unterrichtsplanung, Planungskomplexität, Komplexitätsdimensionen, Lehramtsausbildung

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1 Introduction

Lesson planning as a daily task of schoolteachers (Kang, 2017) fulfills various systematic and individual functions. As a "future-oriented reflection before action" (Conway, 2001, p. 90), it serves to structure upcoming learning opportunities (Krepf & König, 2023) and to lay the foundation for analyzing the success of teachers' teaching thereby developing their professionalism (Meierdirk, 2017). It can also "meet immediate personal needs" (Clark & Yinger, 1987, p. 88), such as helping to regulate emotions, for example, anxiety about teaching, and providing direction, thereby enhancing feelings of security (Seifried, 2009).

To profit from planning in this way, first, one must learn how to plan instruction. This is why most national policy documents include a mandate for the teaching and learning of lesson planning in their respective teacher education (in Germany: KMK, 2022). At the same time, much of the existing research points to strong differences between the planning realities of experienced and novice teachers (e.g. inexperienced teachers, trainee teachers, and student teachers; Griffey & Housner, 1991; Hall & Smith, 2006; Mutton et al., 2011; Westerman, 1991), which calls the success of pedagogical interventions during teacher education into question.

Although some argue that little attention has been paid to lesson planning in research over the past two decades (Kang, 2017; König et al., 2020a), the effort has increased in Germany over the last decade since Wernke and Zierer (2017) asked if lesson planning was a forgotten area of teachers' expertise. Nevertheless, this research is rarely interconnected and often relates back to studies from the 70s and 80s (Großmann & Krüger, 2022). A common thread is that lines are drawn between novices' problems with lesson planning and the challenges or the complexity of the planning task itself (e.g. planning as a *complex non-linear process*, Karlström & Hamza, 2021; as a *complex system*, Munthe & Conway, 2017; as a *challenge*, Derri et al., 2014; König et al., 2020b). Reference is made to dynamic instead of linear decision-making (e.g. Karlström & Hamza, 2021) or the interdependent relationships of planning decisions (e.g. Schrader & Schöb, 2016). However, such references can also be interpreted as signs of teacher education not meeting its expectation: to prepare student teachers for the specific daily lesson planning task appropriately. Building on such insights, it is still important to ask more precisely in what ways this task is complex to draw conclusions about the necessary design to teach and learn lesson planning during teacher education, especially without the context of practical experience. Therefore, this paper first aims to extend the

explanation of planning problems by identifying dimensions of the planning task's complexity with reference to findings from research on task complexity. Hence, one of the questions guiding this work is: 1.) *How can the complexity of the lesson planning task be described in terms of concrete dimensions of complexity?* In doing so, the task itself may be understood better, and these new perspectives could inform new instructional approaches. That is why, secondly, the implications of this extended understanding of the planning task's complexity for teacher education are derived, guided by the question: 2.) *Which conclusions result from the thorough description of the task's complexity for teacher education?*

2 The lesson planning reality

To answer these questions, the (empirical) reality of lesson planning must be considered. In Anglo-American countries, lesson planning is usually based on psychological theory and is primarily perceived as a practical affair (Friesen, 2010). On a basic level, lesson planning "refers to instructional decisions made prior to the execution of plans during teaching" (Sardo-Brown, 1993, p. 63). In a broad sense, these decisions incorporate every thought and act concerned with the organization of what is happening during a lesson. In Anglo-American research, this fundamental understanding of lesson planning has led to decision-making and problem-solving as cognitive processes of lesson planning (Clark & Peterson, 1986; Clark & Yinger, 1987; Shavelson & Stern, 1981) being intensively studied within the decision-making paradigm from the 1970s onwards (Shavelson & Borko, 1979). With Bromme (1981), these aspects were then introduced into the German-language discourse.

Early on, teacher planning was differentiated, for example into daily, weekly, unit, term, and yearly planning, with institutional planning and planning for the next year as additional forms of pre-active planning (Yinger, 1980, p. 113). Nevertheless, the "starting point for … [beginning teachers'] planning is likely to be at the level of the individual lesson" (Mutton et al., 2011, p. 400) possibly since beginning teachers 1.) have a limited influence on early decision-making (many decisions are made for them by their supervisors or mentors), 2.) lack an overview, and 3.) experience the situation as novel. In addition, the concreteness of their mandate – to stand in front of the class and teach within the time frame of a certain lesson – may lead to a narrower focus on individual lessons.

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These lesson plans entail decisions in or about certain areas, categories, building blocks, or elements – integral parts of the various lesson templates that exist for practical usage (Friesen, 2010; Zierer & Seel, 2012), for example, objectives, content, and materials. In German Didactics, they have their equivalent in certain traditional planning models that are usually part of teacher education (Arnold & Koch-Priewe, 2011). During lesson planning, decisions within and on such a set of naïve categories must be made, but their outcomes are uncertain, especially in the case of a lack of experience or routines. That is why the decision-making process in lesson planning seems to be "a particularly complex challenge for novice teachers" (König et al., 2020b, p. 806).
But what are the concrete characteristics of such a complex task, and in what ways does the lesson planning task resemble those characteristics? Who is prone to be affected by this complexity and in what ways? One possible answer is given by Liu and Li (2012) in their ten dimensions of task complexity. Revisiting this integrative framework, complemented by a reference to Sweller et al.'s (2019) Cognitive Load Theory, these ten dimensions are applied to the lesson planning task to gain a deeper, more concrete understanding of its complexity.

2.1 On what makes a task complex

Early on complexity has been an area of interdisciplinary interest. Traditionally, three perspectives on complexity were differentiated: Complexity as "a psychological experience", as "an interaction between task and person characteristics" and as "a function of objective task characteristics" (Campbell, 1988, p. 40). The integration of these three perspectives started with the systematic examination of the difference between objective and subjective task complexity (Maynard & Hakel, 1997). At present, the elaborated and integrative model of Liu and Li (2012), which continues to be expanded (e.g. Hærem et al., 2015), synthesizes ten complexity dimensions out of many existing models of and studies on task complexity. Their task-component-factor-dimension framework presents a task model with several task components each having the potential to complicate the task at hand through complexity contributory factors. Rearranged and recombined, they serve Liu and Li's ten complexity dimensions, which are

(1) size, the "number of task components",
(2) variety, the "diversity in terms of the number of distinguishable and dissimilar task components",

(3) ambiguity, the "degree of unclear, incomplete, or non-specific task components",

(4) relationship, the "interdependency (e.g. conflict, redundancy, dependency) between task components",

(5) variability, the "changes or unstable characteristics of task components",

(6) unreliability, possible "inaccurate and misleading information",

(7) novelty, the "appearance of novel, irregular and non-routine events",

(8) incongruity, the "inconsistency, mismatch, incompatibility, and heterogeneity of task components",

(9) action complexity, the "cognitive and physical requirements inherent in human actions during the performance of a task", and

(10) temporal demand, meaning "task requirement caused by time pressure, concurrency between tasks and between presentations, or other time-related constraints" (Liu & Li, 2012, p. 564).

Liu and Li's (2012) framework can be used to identify possible sources of a task's complexity. Its complexity plays a crucial role especially when the task in question has to be performed in learning environments and by novices, meaning individuals with limited previous knowledge (Endres et al., 2023; Schmid et al., 2011). Central to this reasoning is the limited working memory capacity, in short: The more complex a task – in the language of the Cognitive Load Theory: the higher the *element interactivity* (Ayres, 2006; Chen et al., 2023; Sweller & Chandler, 1994) –, the more intrinsic cognitive load has to be processed in working memory, and the less capacity is free for generative processes and thereby learning (Sweller et al., 1998, 2019). This can state a problem, especially for individuals who have less experience with the task in question, hence have less previous knowledge (meaning fewer schematic representations in long-term memory) and no routinization of the task components. Young teachers, either student or beginning teachers, are such a group of novices. Why can the lesson planning task, applying the ten dimensions of Liu and Li (2012), be considered such a complex task?

2.2 The complexity of the lesson planning task

Most of the complexity dimensions presented above are intertwined with the characteristics of the components of a task (Liu & Li, 2012). Corresponding to these components in the lesson planning task are the various elements, areas, categories, or building blocks of a plan – we call them elements from now on – within which teachers make decisions.

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The question about the elements of the lesson planning task arises since, as we now know, the complexity of any task is dependent on the number of these elements. Quite similar fundamental and formal elements, sometimes reduced or expanded or significantly expanded by other aspects, can be found

- in theories of educational science in the tradition of the "decision-making paradigm" (Shavelson & Borko, 1979, p. 183): A prominent Anglo-American example is the framework by Shavelson and Stern (1981, p. 478) which considers six elements, content, student, materials, goals, activities, and social community. The authors emphasize that the exact sequencing is unknown and probably dependent on task-specifics.
- in didactic traditions, for example in Germany: Zierer and Seel (2012) mention "goals, content, methods, media, time, and space" as "aspects that are present in nearly all didactic models" (p. 16). In the Berlin (and later the Hamburg) model, objectives, content, methods, and media decisions – which are not exhaustive – are always made against the backdrop of individual and situational preconditions (Schulz, 1972). Many German didactic theories are concerned with the justification of the decisions that are being made, most prominently represented by Klafki (1975, 2007). Besides these well-established theoretical frameworks (Lüders, 2018), over 100 primary didactic theories exist in Germany overall (Scholl, 2018), with more recent approaches such as culturally sensitive didactics (Esslinger-Hinz, 2021) and inclusive didactics (e.g. Seitz, 2020) shedding light on important issues that have been neglected before.
- in various lesson plan templates: The most common elements in Anglo-American templates are objectives, materials, starters, activities, and assessments (Friesen, 2010, p. 418). For example, Causton-Theoharis et al. (2008) introduce a template focusing on adaptivity and differentiation containing the elements of lesson context, lesson content, lesson process, lesson product, lesson outline, and reflection. A lesson planning guideline from South Africa from around the same time (Rusznyak & Walton, 2011) presents six sections, namely routine information, purpose, content knowledge, learner diversity, teaching and learning strategies, and sequence of lesson steps. The template is supposed to highlight internal relationships between the considered elements.
- and in empirical studies: As one of the firsts, Zahorik (1975) classified decisions made by teachers during their lesson planning into eight categories, namely objectives, content, activities, materials, diagnosis, evaluation, instruction, and organization. Similar decision areas were also identified early

on by Tillemma (1984). These areas are currently being developed further, for example by König et al. (2021), who distinguish between content transformation, task creation, adaptation to student learning dispositions, clarity of learning objectives, unit contextualization, and phasing.

Despite these slight differences, every tradition or research area assumes (implicitly) that a set of such elements exists and that they relate to one another. The existence of a network of elements within which teachers make their decisions in a template-style manner (e.g. Zaragoza et al., 2021) speaks directly to Liu and Li's (2012) complexity dimensions of size (1) and variety (2): The above-mentioned models (e.g. Friesen, 2010; Shavelson & Stern, 1981) each consist of at least five such elements which are inherently different task components with differing requirements. Another visualization of the diverse elements of the planning process can be found in John's (2006) model which

> does not privilege a fixed order …. The main core is fixed by the aims, objectives, and goals of the plan. However, a number of satellite components rotate around this central element; these represent the foundational aspects of planning, and attached to each are a series of nodes that further sub-divide the key aspects. These nodes and satellites are illustrative and can be changed or developed according to context. (John, 2006, p. 491)

The notion of satellite components or further subcomponents within each element – no matter how many or which constitute the model in question – is important and valuable in itself, but furthermore, John's allusion to their context-dependency anticipates the following complexity dimensions.

The lesson planning task is ambiguous (3), variable (5), and unreliable (6), depending on the ever-changing context and the degrees of freedom and autonomy a teacher has in their planning activities (Munthe, 2001). In most Western countries, where curricula with abstract requirements on content and objectives have to be met, the exact way of implementation is left in the hands of the teachers themselves (Scholl, 2012). In conjunction with specifying objectives, teachers must make both content and methodological decisions, particularly when curricula follow the principle of output governance, as is the case in Germany (e.g. Ertl, 2006). Even if standards inside a school are established, lesson planning is still dependent on the individual teacher's perception and interpretation of the students' characteristics, the teacher's diagnostic abilities, and the anticipated uncertainties of the classroom environment.

Most directly related to the construct of element interactivity from Cognitive Load Theory (Chen et al., 2023) are the aspects of relationships (4) between the task components and their incongruity (8). The elements of a lesson plan, for example, content, students, and goals, do not exist independently from

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each other – quite the contrary. The element 'students' consists of several subcomponents (John's [2006] satellite components), for example, students' interests, motivations, and prior knowledge, that must be related to decisions on the many other elements. For instance, the prior knowledge of students diagnosed by a teacher influences decisions about which goals shall be accomplished in a certain teaching-learning unit and where to start content-wise. At the same time, content and goal depend on each other and influence decisions for and against certain methods and materials. Vice versa, the possible unavailability of material or media might have the effect that decisions about goals or content have to be modified. These examples suggest that incongruent decisions have no place in lesson planning and that the relationships between all elements must always be considered while the lesson plan evolves, no matter where the teacher starts the planning process. The importance of interdependence is, again, stressed by John (2006, p. 492) who "underlines the point that teaching, learning, resources, tasks, tools, context, and objectives are inter-connected rather than separated". Interdependence as a task demand of *good* lesson planning is also emphasized in German didactics, especially in Heimann's *Berlin Model* (Heimann, 1962/1976). This task demand has been further developed, for example, to the requirement of creating coherence for both the surface and deep structure of teaching, as well as the coherence between them (Esslinger-Hinz, 2021). Currently, research with general didactic references also attempts to empirically model interdependent planning decisions as a professional skill (Scholl et al., 2022).

This basic idea of German-language general didactic models such as the Berlin Model, which to this day is one of the most prominent didactic approaches in Germany (Lüders, 2018; Scholl et al., 2020), to position lesson planning towards interactive planning areas, is also represented in international approaches that refer to this more German-language strand of the discussion on lesson planning. This can be shown representatively in the Norwegian *Model of Didactic Relations* (Bjørndal & Lieberg, 1978), which was further developed by Karlström and Hamza (2021) as part of an empirical study in Sweden and is – on a superficial level – almost identical to the Berlin Model. In their study, Karlström and Hamza were able to confirm the planning components of the Model of Didactic Relations using *Didactic Modeling* (Wickman et al., 2020; while also adding three meta-aspects for teaching lesson planning).

The individuality of the students and the possibility of changes in curricula and assessment criteria are some examples of why the lesson planning task requires teachers to consider novel information (7) often. Especially teachers with less experience in general or in the specific content area cannot build

on routinized planning activities to face novelty (Seifried, 2009; Westerman, 1991; Yinger, 1980). Change happens all the time and needs to be incorporated into lesson plans (e.g. Brühwiler & Blatchford, 2011; Corno, 2008). Even experienced teachers can seldom copy a preexisting lesson plan from another class or year or – if they do so – fail to take the individuality of the students and other prerequisites into account.

The action complexity (9) (e.g. in a narrower sense related to the transfer of action, Stender et al., 2017, in a broader sense to curriculum development, Wood & Butt, 2014) which in the case of lesson planning might be the physical or psychological way a plan is kept hold of, can or cannot be routinized (Roche et al., 2014). Experienced teachers may just take a few notes, sometimes even a think-through may be enough. At the other extreme, a filled-in template or a whole text describing in every single detail what is supposed to happen during the lesson may be the chosen path forward for some other teachers, student teachers, and pre-service teachers with no planning routines (Westerman, 1991; Yinger, 1980) in particular. Sometimes such a detailed plan is a tool of examination in teacher education (e.g. in Germany, Esslinger-Hinz, 2016). The continuum between these variants depends on the teacher's experience and albeit to a lesser degree personal preferences (Hall & Smith, 2006). 'The more routinization, the less complex the perception of the task' should be a valid statement for all though, irrespective of the documentation of the planning process.

Finally, temporal demands (10) might increase the perceived complexity of the lesson planning task (John, 2006; Livingston & Borko, 1989), for instance, if many classes must be prepared at once or if unexpected incidents lead to a shortage of time. Teachers possibly experience strain when they feel that they rarely finish their planning activities as there is always a next week, a next topic, or a next class that could need some additional attention. For some teachers, this might elicit a feeling of time pressure further complicating the task at hand. This is especially the case with inexperienced teachers. They make a smaller number (Griffey & Housner, 1991) of relatively time-consuming (Livingston & Borko, 1989) planning decisions for the upcoming individual lesson (Hall & Smith, 2006) with a similar weekly investment of lesson planning time as experienced teachers (Ball et al., 2007; OECD, 2019) under the time pressure of the approaching deadline.

All in all, for each of the ten complexity dimensions assembled by Liu and Li (2012), theoretical arguments can be made as to why they may apply to the lesson planning task. While there has not been explicit research on the complexity dimensions of the lesson planning task as far as we know, some

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of the empirical observations made about planning problems of novices may be reframed and looked upon from the perspective of the complexity of the task itself.

3 How the complexity of lesson planning may affect student teachers

The presented framework of lesson planning as a complex task may offer additional explanations for the various difficulties novice teachers face when planning. These difficulties are well-documented in the existing research.

John (2006, p. 488) describes the planning of experienced teachers as "a simultaneous consideration of the … elements [learner, content, activities, etc.], rather than a step-by-step or linear progression of decision-making" while "Novices describe their planning as time-consuming as they struggle to make sense out of the cornucopia of decisions they have to make regarding content, management, time, pacing, and resources" (John, 2006, p. 489). Quite similarly, the distinction between the dynamic planning of experienced teachers and the linear planning of student teachers has been made before by Westerman (1991). More recently, Großmann and Krüger (2022) report problems of preservice teachers with interdependent decision-making as well. These findings can be explained by the high element interactivity of the lesson planning task and the relationships between the task elements that must be considered to plan coherently. The simultaneous consideration of many task elements is only possible if working memory capacities are sufficient. It is safe to assume that previous knowledge and routines that are stored in the long-term memory of experienced teachers help them bypass their limited working memory capacities (Sweller et al., 2019). The result is dynamic planning (observed e.g. by John, 2006) which poses a huge challenge for novices. To master the situation, novices take a linear approach because their limited working memory capacities and their shortage of routines in long-term memory do not allow for dynamic decision-making under the simultaneous consideration of all interrelated entities.

Two major problems of novice teachers outlined by Mutton et al. (2011) based on the framework by Calderhead (2013) are their "lack of highly contextualised knowledge" and their disability to allow for flexibility which often shows in the dominance of a "lesson plan as a 'script' … in the early stages of the development of many teachers" (Mutton et al., 2011, p. 412). Such knowledge includes for example the idea of the instructional context (Borko et al., 1990),

general pedagogical (König et al., 2020b) or conceptual (mathematical) knowledge (Lui & Bonner, 2016), and knowledge of curricular requirements (Siuty et al., 2018). Even newly qualified teachers in their second and third years were still learning to allow flexibility in their lesson planning as shown by Mutton et al. (2011), a result that speaks to the complexity dimensions of unreliability and novelty. As usual as novel appearances are in the teaching profession: Novices do not have the resources or the knowledge to plan for them. They use the lesson plans as safety nets, resulting in script-like plans described by the authors. This seems necessary because inexperienced teachers have a strong need for security, to avoid making possible mistakes in uncertain lessons and not to fail (Bullough, 1987; Koeppen, 1998; Seifried, 2009). Their uncertainty is reinforced by the concern, knowing about one's own inexperience, that there might be better decision options (Borko & Livingston, 1989).

Planning lessons as scripts eliminates ambiguity and potential unreliability and is an effective way to deal with the complexity of the task – albeit an ineffective way to learn the relationships between the task components. It should come as no surprise that especially adaptive decision-making is getting not enough consideration (Causton-Theoharis et al., 2008) as adaptivity in lesson plans is a source of such ambiguity. One finding underlining this observation is that beginning teachers make more generic than subject-specific decisions during lesson planning (König et al., 2020a) even though "Pre-service teachers are required to reflect on subject-specific issues if they want to make planning decisions on selecting adequate learning tasks and assigning them to students" (p. 135). It seems as if novice teachers bypass the ambiguity of individual student characteristics by focusing on generic decisions, thereby ignoring one task component responsible for heightened task complexity, and thereby unconsciously reducing internal load (Ayres, 2006; Pollock et al., 2002).

Differences in lesson planning and differences in the actual lessons go hand in hand, of course: Griffey and Housner (1991) found experienced teachers run lessons „more businesslike; they were focused on content and student mastery of that content" while "Inexperienced teachers were characterized as being abrupt and prone to spontaneously shift activities during lessons for no obvious curricular reason" (p. 202). Beginning teachers do not penetrate the task because they possess neither the routines to handle the variety of the task elements nor those to deal with the novelty or ambiguity of information available while planning.

In summary, the high complexity of the lesson planning task affects teachers' lesson plans and planning decisions and may be the reason why beginning teachers ignore certain elements while planning and turn out lesson plans

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that are linear and feel incoherent or insular. It is safe to assume that their lesson plans are qualitatively inferior to those of experienced teachers. Beginning teachers have to deal with the complex lesson planning task under the restrictions of their limited knowledge, routines, and working memory capacities: "The analysis of teaching as a complex cognitive skill … accounts for these differences by postulating that novices' cognitive schemata are less elaborate, interconnected, and accessible than those of experts and that their pedagogical reasoning skills are less well developed" (Borko & Livingston, 1989, p. 492). This seems to be true for the teaching skill in general as well as the skill to plan lessons as one aspect of the teaching profession. The question arises of how teacher education programs may help student teachers acquire skills to deal with this complexity in effective ways while at the same time recognizing the regular limitations of novices in comparison to experts.

4 Consequences for student teacher education and prospects

As we have seen, many characteristics of the lesson planning task resemble the complexity dimensions of complex tasks (Liu & Li, 2012). The complexity of the lesson planning task, especially the inherent interactivity of its task elements and the need for routinization and expertise may be the reason for the many problems that student teachers or inexperienced teachers face when they are planning their lessons. In addition, existing findings can be interpreted as evidence of further complexity dimensions, for example, ambiguity, unreliability, and novelty. It is possible that this expanded understanding of complexity will now help to better understand why previous approaches to promoting lesson planning have significant potential but are not used in a way to fully solve the planning problems of novices. This applies, for example, to cooperative learning (Weitzel & Blank, 2019), concrete programs to learn from teaching (Hiebert et al., 2007), the (Japanese) Lesson Study approach (Cheung & Yee Wong, 2014; Regan et al., 2016) or digital planning tools (Celik & Magoulas, 2016; Prieto et al., 2013; Strickroth, 2019) – all of which could consider further complexity dimensions of the planning task.

Against the background of the differentiated understanding of the complexity of the planning task, the question can therefore be asked: What does this mean for teacher education? How can student teachers be supported when exercising their first lesson planning? How can they overcome the initial complexity of the task? A critical aspect of the answers may be the consideration

of the cognitive load, which from the perspective of Cognitive Load Theory appears to be associated with the development of the dimensions of the complex planning task, and which has not been considered sufficiently in previous approaches of teacher training.

One consequence could be the reduction of the complexity of the lesson planning task for novices at the beginning of their learning of how to plan lessons. This is a challenge not only for instruction but also for lesson planning guidelines which should "be accessible to beginning student teachers, without compromising the complexities that reveal the inner logic of lesson coherence to them" (Rusznyak & Walton, 2011, p. 272). While we agree that the inner logic of lesson coherence should not be lost under any circumstances, the number of relevant elements in this interaction must be dialed down if one wants to improve novices' learning in accordance with the assumptions made above. This can be accomplished by reducing the element interactivity of the task and thereby the intrinsic load (Pollock et al., 2002; Sweller & Chandler, 1994) to free working memory capacities of the learners for learning procedures. The reduction of element interactivity can take many different forms, for example through *isolated-element procedures* (Pollock et al., 2002), through which partial elements of a task are initially processed in isolation and only increasingly combined to form the overall task, or modular presentation of solution procedures as *part-whole sequencing* (Gerjets et al., 2004), whereby the overall task is broken down into many subtasks that can be processed flexibly and sequentially without dissolving the dynamics of planning thinking into the linearity of a planning algorithm. In particular, the development of digital planning tools is seen as an opportunity to redesign the planning task at least in the sense of a modification as a substantial, complexity-reducing change in learning processes (Puentedura, 2006, 2013; e.g. also RAT model, Hughes et al., 2006). These insights are well-known and applied in other contexts (e.g. micro teaching, Klinzing, 2002), however rarely discussed in learning lesson planning.

One could argue that a reduction of planning elements risks the professional development of teacher students: After all, there is the complexity of all task elements in the real task. Following this train of thought but also considering the potential of overwhelming cognitive load, stability in certain task elements may be key. However, we do not argue for a general reduction of planning elements at all times – which would indeed risk professionalization – but for a slower start, for early exercises focusing on selected planning elements and especially their interconnections.

A course program for student teachers based on the *Four-Component Instructional Design* (4C/ID) model (van Merriënboer & Kirschner, 2018) that teaches

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lesson planning while taking into consideration the problem of high element interactivity of the initial task is deemed worthy of further consideration. The 4C/ID model is particularly suitable since it is based on Cognitive Load Theory and applies to complex tasks – like the lesson planning task – while following a holistic design approach. Special consideration is given to the design of learning tasks, the first of the model's four components, supplemented by supportive information, procedural information, and part-task practice.

In addition to size, variety, relationships, and incongruity as complexity dimensions directly linked to the concepts above, other dimensions like the ambiguous, variable, unreliable, and novel nature of the planning task can be pursued in the design of the learning task. From this perspective, a recommendation is to let inexperienced teachers plan for 1.) few students/very small classes, 2.) the same learning group again and again, and 3.) protected from situational changes. If early teacher education wants to prevent the bypassing of student heterogeneity in lesson planning, the task has to be simplified as much as possible through consistency and support.

While the validity of these assumptions, for example, the high intrinsic load of the lesson planning task, could use some empirical evidence beyond theoretical arguments, we want to encourage the usage of theoretical frameworks on instructional design when preparing instruction. This is true for student teachers as well as for their teachers.

Learning to plan is not completed when student teachers finish their formal education and the lines between theory and practice blur with prolonged internships during teacher education and more and more student teachers teaching at schools without a degree while studying because of teacher shortage (Porsch & Reintjes, 2023). While it is true that practical experience will form student teachers' planning further (Mutton et al., 2011), because they, for example, increasingly incorporate deeper structures such as student understanding into their planning as they gain practical experience (Koberstein-Schwarz & Meisert, 2022), teacher education still needs to provide a solid basis for lesson planning. That is why instruction must take the peculiarities of human cognition and the task at hand into consideration every step of the way, this means to recognize the complexity of a task, to identify how this complexity arises, and then to link these insights to the learning process. Many complexity dimensions can be linked to intrinsic cognitive load, and its reduction requires a manipulation of the task, in one way or another (Ayres, 2006). This article provides theoretical ideas based on theoretical assumptions and empirical research that of course need further evaluation, but we believe that they can improve teacher education in the future, although they, again,

connect back to the research on lesson planning that is heavily influenced by cognitive psychology (Großmann & Krüger, 2022).

It should not be forgotten that potential consequences for teacher education are – of course – context-dependent and must be adapted to the specific situation accordingly. Questions concerning this context are how, when, and where learning to plan is integrated into teacher education as well as if it does or does not precede first practical experiences in school. The suggested ideas may provide guidance for answering these questions – they are not new, but they might reinforce from a cognitive perspective why it is important to take small and thoughtful steps when learning lesson planning before larger steps accelerate the process towards comprehensive planning.

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