

Designing a Workshop to Support Teacher Customization of Curricula

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Abstract: We report on design-based research to refine a professional development workshop that supports teachers to customize online curricula. We iteratively design representations to make the knowledge integration pedagogy of the curricula visible. We study ways to make the work of students using the curricula actionable for participating teachers. We analyze participants' trajectories across the three iterations of the workshop. Initially, when participants realized they could customize the online curriculum, they developed feelings of ownership. Then, as participants deepened their understanding of the pedagogy, they began to use it to evaluate their own instruction. The trajectory culminated in participants connecting the pedagogy to student work from their own classroom. This led to a shift from focusing on remedies for misconceptions to seeking opportunities for building on students' nascent ideas when customizing. The workshop refinements empowered teachers to mobilize the pedagogy to interpret their students' work to inform their customization decisions.

Keywords: professional development, design-based research, technology-enhanced learning

Major issues and objective

When teachers implement new materials, they often customize instruction to align with existing classroom practice, particularly when the materials are designed based on a different pedagogical framework (Matuk, et al., 2016; Remillard, 2000; Schneider, et al. 2005). We explore the design and impact of a professional development workshop that takes advantage of technology to make curriculum designers' pedagogical design intentions visible alongside the curriculum and to enable teachers to use student work to plan customizations. We investigate how these supports enable teachers to appreciate the instructional goals of the materials and make connections to their students' ideas. The workshop supported teachers to customize instruction while attending to contextual constraints such as available classroom time and new standards. Furthermore, we designed technologies to help teachers with limited time to efficiently gather data to inform their customizations. Teachers often lack time to gather and respond to data they perceive as relevant (Kerr, et al., 2006) leading to mixed outcomes for students (e.g., Bismack et al, 2015; Davis, et al., 2017; McNeil, 2009). When teachers anchor their customizations in evidence, particularly from student work, they are able to make better customizations (Gerard, et al. 2010).

The workshop design draws on the notion of educative materials (e.g., Davis and Krajcik, 2005) to support the development of teachers' pedagogical design capacity (Brown, 2009; Brown & Edelson, 2003). To support teachers' pedagogical design capacity, we used a visual representation of the curriculum to make visible the pedagogical intention behind each activity in the units visible. The representation supports teachers to consider pedagogical implications as they planned revisions customizations to the curriculum. Because attending to student work and ideas has been shown to lead to more impactful instruction (e.g., Carpenter, et al., 1989; Coffey, et al., 2011; Fennema, et al., 1996), the workshop design guides teachers to examine student work collected in their own classrooms before they plan and implement their customizations. Specifically, the workshop design engages teachers in goal setting, analyzing student work to identify possible revisions, and designing customizations to the content and assessments embedded within the curriculum based on the analysis. The teachers then implement the customized units and return for a subsequent workshop. We refined the workshop based on the researcher and teacher reflections. We describe the three design iterations and the impact design changes had on teachers' use of student work and pedagogy. Our research questions are:

- How do improvements in the representation of the pedagogical framework underlying the curriculum facilitate teachers' consideration of pedagogy while customizing?
- How do refinements in providing access to student work support teachers to analyze that work as they customize the curriculum and their instructional approach?

Workshop design and iterations

Knowledge Integration framework

The Knowledge Integration (KI) Pedagogical Framework (Linn & Eylon, 2011) informs both the design of the interactive online science units and the workshop for teachers. The KI framework builds on constructivist perspectives (Inhelder & Piaget, 1958) that acknowledge that learners bring multiple prior ideas about scientific phenomena into the classroom and engages students in exploring their own and new ideas as they develop coherent understanding. In the context of the online science units, each lesson in the unit follows the research-based KI processes (Linn & Eylon, 2011). Units might start with activities where students make predictions about phenomena to *elicit* their prior knowledge. Next students might *discover* new ideas by engaging with interactive scientific models and discussing ideas with peers. Having accumulated a repertoire of ideas, students then *distinguish* among their ideas by testing their hypotheses in new scenarios or sorting which ideas are relevant under certain circumstances. Finally, students *reflect* on how their new ideas fit with their initial ideas.

We designed the professional development workshops following the same pedagogy as the interactive online science units and implemented the workshops with an online unit using the same technology as the online science units. By using the same technologies and pedagogy, the workshop modeled the instructional approach that it also advocated. Applying the KI framework to the workshop design, we first elicit teachers' ideas about their goals for student learning and what they hope to achieve using the unit. Next, we support the teachers to discover new ideas about how the unit is functioning in their classrooms through analysis of student work from the unit they are customizing. Teachers analyze student written explanations from key assessments embedded within the unit in conjunction with their recollections of student learning while teaching to determine areas of the unit that need to be strengthened in order for students to achieve mastery of aligned standards. This spurs the teachers to think of ways to customize the unit to strengthen student learning. Next, we introduce the idea of KI pedagogy as a means to distinguish which customizations to make and to consider where new activities fit with existing activities. By considering the pedagogical intention of the activities already in the unit, teachers can distinguish how best to integrate new activities. Finally, teachers teach the customized version of the unit and reflect on the efficacy of their customizations.

Making the Knowledge Integration pedagogy visible

At the workshop, we made the KI pedagogy in the unit visible. We made the KI pedagogy underlying the curriculum design visible in two ways. First, we supported teachers to connect KI processes such as distinguishing ideas to examples of activities in their existing practice. This deepened understanding of the pedagogy and of the characteristics of their own practice. Second, we used a visual representation of the KI processes underlying each activity in each unit to illustrate the interactions across processes (Figure 1). Lastly, we designed the workshop following the same pedagogical framework, KI, in order to model the instructional approach for teachers.

Connecting KI to teacher practice

In the first workshop we introduced the KI processes and some examples of activities from the units that engaged each process. Then, teachers brainstormed examples of their own activities and classroom practices, recorded them on post-it notes and sorted the examples by KI process. For example, teachers sorted their use of Know-Want to Know-Learned (KWL) charts as eliciting students' ideas and their use of Venn diagram graphic organizers as helping students distinguish among their ideas. In the second workshop, researchers similarly demonstrated examples from the units, and illustrated how each lesson of the unit engages students in each of the KI processes. Then teachers, many of whom were now familiar with the KI processes from the first workshop, met in small groups to discuss how their initial customization ideas aligned with the KI processes. In the third workshop, we supported the teachers to connect the KI pedagogy to their classroom assessment. We generated a sample of their students' responses from the log files and annotated the responses by their students' degree of integrated understanding.

Visual representation of KI in the unit

In the first workshop we used notecards to represent the lessons in each unit and color-coded post-it notes to represent the individual KI processes in each activity in the unit. Teachers found the notecards and post-its useful for understanding the design of the units and inserting their own activities. However, they were difficult to use during collaboration and hard to share. In the second workshop, we transitioned to using online technology to represent the units. We created an online version of the notecard and post-it approach using Google slides. We initially created one slide for each lesson, with colored boxes representing the processes in the activities. Teachers

found this approach frustrating because they could not easily add their own activities and the activities were organized only by KI process and not sequential order.

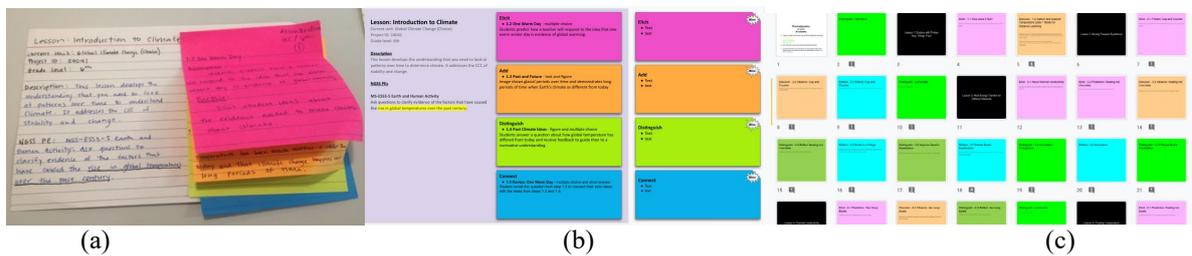


Figure 1. Progression of the planning tool: (a) Year 1, (b) Year 2 and (c) Year 3. The color of each post-it/text box/slide represents the KI process engaged by the activity written on it: Pink for eliciting ideas, orange for discovering ideas, green for distinguishing ideas, and blue for reflecting on ideas.

The third representation improved the use of Google slides. Each activity in the lesson was assigned a separate slide, making it easy to rearrange the sequence and to add new activities. As shown in the figure, a black slide was used to indicate a new lesson. Each step in the lesson was then represented with a slide color-coded for the KI process it represented. This enabled participants to appreciate the overall structure of the unit as well as the role of each activity. Teachers could easily add new activities from color-coded template slides, prompting them to consider the KI process engaged by the activity they intended to add. This representation enabled greater collaboration among teachers customizing the same unit. It also gave teachers the ability to move between focusing on the details of one activity and focusing on the composition of the unit as a whole.

Making student work accessible

We engaged teachers in analysis of student work to help inform the customization decisions they make and refined our design for accessing student work across the three workshops (Figure 2). In the first workshop, teachers were grouped by unit. Each group received a spreadsheet with a random selection of student responses to an open explanation question in the unit. For each unit, we selected an open explanation question that assessed one of the standards addressed by the unit and came at a point after students had engaged in a full KI cycle around that standard. Teachers found the examples informative for discussing the unit and student understanding with their peers. They were reluctant to use these examples when customizing their own instruction, preferring to rely on their classroom observations (e.g. Kerr, et al., 2006). This motivated a redesign to connect teachers to their own students' work. In the second workshop, we developed learning analytics that summarized student work on an open explanation question in the unit and created personalized summaries for each teacher, based on the responses of their students. Teachers found the summary useful for explaining their students' progress and highlighting specific ideas that students needed more support to develop. They continued to also rely on their own recollections. In the third workshop, we enabled teachers to examine their student work immediately during instruction as well as during the workshop. During instruction, we used the learning analytics to generate the summary of student work as the teacher implemented the unit. Some teachers began identifying ways to build on their students' ideas when they got the summary during instruction and further developed their ideas during the workshop. At the workshop, we also engaged teachers in sorting a sample of their own students' responses by the level of KI to deepen their understanding. After they scored the responses, we had teachers compare their sorting with researchers' annotated comments on their students' responses. Thus, across the three workshops, we increased access to the specific student work generated in each teachers' classroom. We also helped teachers contextualize their student work by analyzing it at the same time as they were teaching the unit.

Methods

To answer our research questions, we analyzed teacher reflections across the three workshops held over three years. We connect themes from their reflections to the design iterations. We examine how teachers take advantage of their students' work and connect it to the KI pedagogy to strengthen evidence-based instruction. We had to omit analysis of a third aspect of the workshops, authoring technologies, due to space limitations. A subsequent paper will describe our refinements of the authoring technologies for teachers and the teacher reflections on it.

Participants

Seventeen teachers attended the first workshop, 19 teachers attended the second workshop, and 23 attended the third workshop. Only teachers who attended at least two of the workshops were included for analysis: twenty-five teachers representing 10 schools participated in at least two of the customization workshops. 56% of teachers were present during all three workshops.

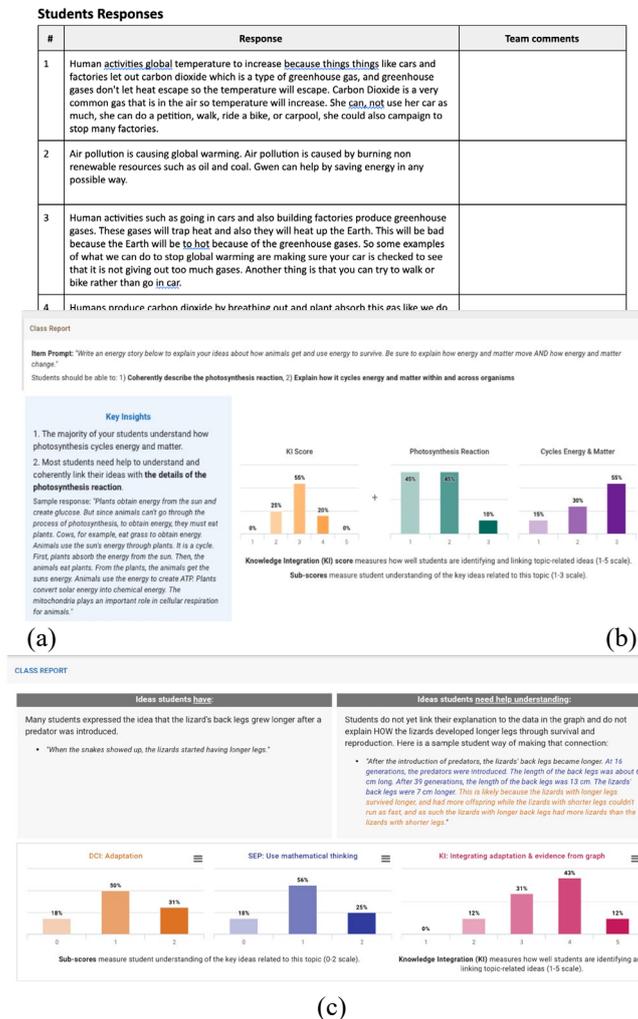


Figure 2. Representation of students work to guide teacher customization in (a) year 1, (b) year 2 and (c) year 3.

Data sources and analytic procedure

Our data comes from teacher written reflections and researcher field notes from each of the three workshops, taking place in June of three consecutive years. At the end of each workshop teachers were asked to write reflections on their experience of the customization process. The online unit guiding the workshop logged teachers' responses to the reflection questions. Teacher responses to the following questions were used in our analyses:

- What are some things you learned or have taken away from engaging in this customization process and sharing with other teachers?
- Was this customization process and reflecting on the KI cycle helpful for you in thinking about how to achieve your NGSS and other curricular goals?
- Do you think you could use this process again to customize another unit you'd like to run?
- Please share any other reflections of feedback you have from the workshop

Teacher responses to all four questions in each year were combined to represent each teacher's reflection for that year. We began coding with three a priori categories reflecting our research questions and design focus on making pedagogy visible and using student work: *Value of KI Pedagogy*, which were statements about the

affordances of considering KI during customization; *Use of Student Work*, which were statements about the utility of student work for customization; and *Value of Technology*, which were statements about engaging with the technology to author their customizations in the online units (omitted for this paper). We used inductive coding (Thomas, 2006) to determine themes within each of these categories to uncover trends in how teachers' reflections within the categories evolved over time. The themes represent the most common ideas teachers expressed in each category of reflection. The themes for each category can be found in Table 1. While analyzing the reflections, we noticed teachers expressing a sense of ownership of the curriculum, so we added *Sense of Ownership* as a category in our coding scheme. Changes in the way themes were represented and discussed at each workshop illustrate the ways in which the refinement of the workshop activities have shaped the teachers' experiences of and approach to customization.

Table 1: Coding scheme and emergent themes for teacher reflections on the workshops

Sense of Ownership	Value of KI Pedagogy	Use of Student Work	Value of Technology
Customization is possible	KI clarifies unit learning objective	Identify misconceptions	Newly aware of tool
Able to meet own goals	KI provides insight into unit design	Identify areas where students struggle	Need individual support to use tools
Able to meet student needs	KI informs customization decisions	Find student ideas to build on	Time consuming to use the tools
Opportunity to integrate resources	KI supports reflection on own practice	Customize to address student needs	Tools make customization accessible

Results and discussion

Teacher trajectory across three years

As we refined the workshop design, the focus of the teachers' reflections shifted (Figure 3). In the first year of the workshop, the most prominent category of teacher reflection was a newfound sense of ownership reflected in the possibility of engaging in customization. In year two, the focus shifted to the use of student work, which aligns with the redesign that provided teachers with student work from their own classroom. Finally, in year three, the focus shifted to the usability of the customization technology, the details of which are beyond the scope of this paper. We analyze the themes of workshop reflections within each category across the three years to connect workshop design features to the customization focus.

Sense of ownership

Ownership emerged as a focus of teacher reflections at the first workshop. The teachers were excited to realize that they could customize the online units. When expressing their sense of ownership after the first workshop, 43% of the 17 teachers present at that workshop wrote that the customization process had enabled them to envision a way to integrate the rest of their successful classroom activities into the online curriculum unit. For example, one teacher wrote that the customization process was "A bit overwhelming also, but very helpful to really make it part of the curriculum, intertwined with the actual curriculum, instead of using the WISE projects as separate from the curriculum." Another 33% expressed that engaging in the customization process enabled them to meet their own goals. One teacher wrote, "Yes, this process made it realistic to reach our curricular goals. I liked reflecting on what in the project is addressing what we want and thinking of ways to add offline [activities]." By the second and third years, there were fewer direct mentions of ownership. This decrease most likely reflects the teachers' experiences in the preceding workshops. It became less of a novelty to customize online materials.

Value of KI pedagogy

Over the course of the three workshops, teachers shifted the way they spoke about the relevance of KI for their customization process. Knowledge integration was explicitly mentioned the most during the first year of the

workshop. This reflects the amount of workshop time dedicated to developing an understanding of the pedagogical framework and the success of the activity where teachers connected the processes to their existing practice. During the first year, nine teachers mentioned insights from knowledge integration in their reflections. Teachers expressed a variety of insights afforded by the activities to make knowledge integration visible. Thirty percent of teachers described KI as useful for clarifying the learning objectives associated with each unit. Another 30% said the KI framework provided insight into the design intentions of the unit. Thirty percent also described KI as useful for deciding where and how to make customizations.

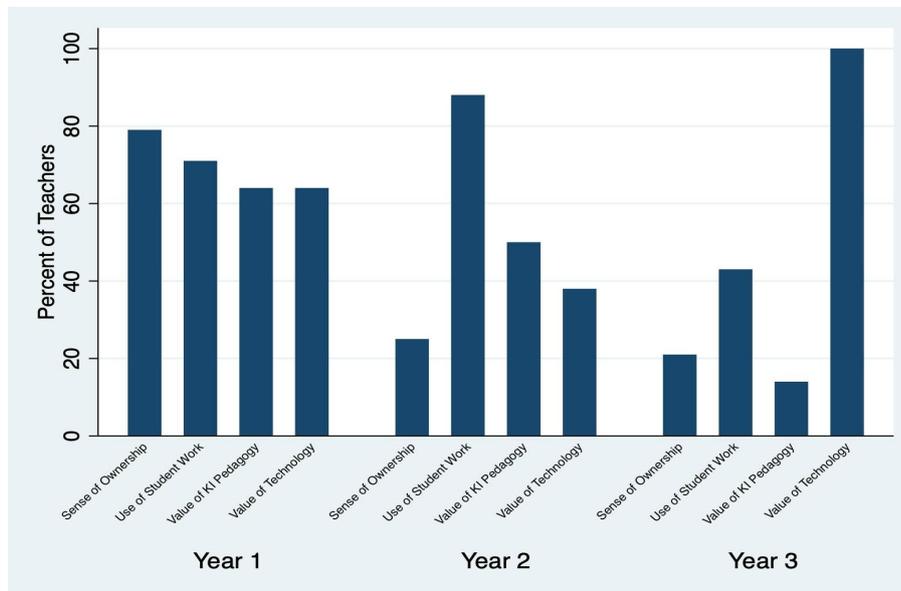


Figure 3. Percent of teachers in attendance during each workshop with reflections in each category

In the second and third years of the workshop, fewer teachers mentioned KI directly, consistent with their increased familiarity with KI and how it informs the units. Furthermore, evidence emerged that teachers had internalized the framework into their goal setting processes since half of the mentions of KI during the second year and all of the mentions during the third year consisted of teachers reflecting on how they implemented KI processes in their own practice. For example, one teacher in the second year wrote “I feel my teaching practice is strong in terms of eliciting ideas, good in terms of adding ideas, and fair in terms of reflecting. I would really like to work on the distinguishing part of the cycle” and another said, “I appreciate time to reflect on my practice and how to be more effective. Rarely do you get a chance during the year to think so deeply about the exact steps of how students connect new information to what they already know.”

Thus, the workshop activities supported teachers to reflect on how their own pedagogy interacts with the pedagogy of the units and consider how to improve the units to facilitate student knowledge integration. As teachers considered the KI process of the activities in the units and the activities they were adding, they were supported to reflect on the types of thinking they were asking students to do in their own activities. Prior research shows that teachers typically neglect providing students with opportunities to distinguish among their ideas (Wiley, et al. 2019). By increasing teacher awareness of how their own classroom practices can engage each of the KI processes and supporting teachers to visualize the pedagogical design intention for each activity in the unit, the teachers were better able to evaluate their own practice using the pedagogy. As one researcher overheard during a workshop, a group of teachers exclaimed “We need more green [color of distinguishing activities]!” when evaluating their unit customizations.

Teacher use of student work

Across the three workshops, we refined the activities to guide teacher engagement with student work, increasing access to the specific student work generated in each teacher’s own classroom. Teachers shifted how they discussed the relevance and utility of student work for informing their customizations as the workshops progressed. These shifts corresponded with the changes in how we engaged teachers with student work during the workshop. While only one teacher mentioned the use of student work during the first workshop, student work was the most prominent category during the second workshop. This prominence corresponds with our change to showing teachers student work from their own students and introducing learning analytics to provide each teacher

with a summary of the ideas in their class. In year two, 55% of teachers found the summaries of student work to be helpful for identifying areas where students were struggling or for identifying misconceptions. This is notable given the open-ended nature of the reflection questions and teachers' specific focus on understanding their students' struggles. One teacher reflected, "Students are struggling to incorporate evidence from models in their explanations." A smaller percentage of teachers (22% each) mentioned in their reflections that analyzing student work was useful for identifying productive student ideas to build on or expressed a direct connection between the ideas in their students' work and their plans for how to customize.

By year three, we were excited to note, teachers' reflections shifted away from identifying incorrect ideas towards using student work to find productive ideas to build on to help students develop more integrated perspectives. The majority of teachers' reflections on student work (86%) expressed a connection between the ideas they saw and the customizations they were planning. The remaining 14% said they found ideas to build on. For example, one teacher wrote, "I love the reflective time and the strategies you teach me to become a wiser user of my student responses/data. I also love the ways you present for thinking about teaching to the needs of my students. I think being able to customize the units to address my preconceptions in student knowledge integration and/or ways of teaching will empower my students to become stronger explainers and reasoners." Another teacher reflected, "due to the sorting activity, I was able to recognize the gaps in student achievement, which spurred me to create scaffolds and re-plan steps for the unit." This shift towards viewing student ideas as productive was more pronounced as the teachers had the opportunity to review their class summary during instruction and to use it for in-the-moment teaching customizations. When they saw it again during the workshop, they were able to reflect on their customization goals. This reaction is consistent with the multiple opportunities to reflect on the same student work. It also aligns with the opportunity to use the class summary during instruction to incorporate the classroom context as teachers got started on building on students' ideas.

Conclusions

We iteratively designed a professional development workshop intended to support customization by making the pedagogy behind our curriculum visible and engaging teachers in analysis of their students' work. We found that the activities designed to make KI visible were initially successful and, as they were improved, became more useful to the teachers. The representation in the first workshop made the instructional goals of each unit explicit and enabled teachers to articulate the connections to their own goals. The move to Google slides and the improvements in the representation provided a more robust view of the KI pedagogy, supported multiple perspectives on the unit, and increased opportunities for teachers to collaborate on customizations. Furthermore, refining the representation of the pedagogy strengthened teachers' ability to integrate their own activities into the unit and led to increased sophistication of the reflections on their own pedagogy as they customized the units.

Our methods for making student work accessible increased the likelihood that teachers considered student work as evidence to inform their customizations. This was especially true if the student work was from their own classroom and was directly related to their interactions with students while teaching. In addition, teachers reported that access to the class summary during instruction enabled them to build on their students' ideas. Further, the combination of the class summary and examples of their students' responses provided teachers with a coherent picture of their students' needs and shifted them away from a deficit view of students' ideas as misconceptions or wrong to a KI view of the value of building on student ideas to encourage coherent understanding.

These results illustrate the challenges and value of careful design of teacher workshops. They show that making the pedagogy visible when engaging teachers in customizing curricula has the potential to extend beyond the unit being customized. Teachers reported using the KI pedagogy in their own planning and to connect their offline activities to the online curriculum. These results show the benefit of making student work accessible to help teachers incorporate all their students' ideas rather than only those they recollect at the workshop. The results support viewing the customization process as a trajectory. It starts with ensuring that teachers feel ownership of the customization process. It continues by deepening understanding of the pedagogy behind the instructional design so that the participants integrate it into their own pedagogy. It culminates in connecting the pedagogy to the learning activities of the students. In this case, illustrated by a shift from a focus on addressing misconceptions to a focus on building on the nascent ideas developed by the learners.

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