

Effective Lesson Plans in Transportation

Project 1914
February 2021

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Introduction

This research focused on developing a suite of standards-aligned, rigorous lesson plans for secondary school teachers centered on transportation issues. The first phase of the grant project focused on training a cadre of prospective K-12 secondary school teachers to develop rigorous, standards-aligned lesson plans. Six students were recruited from across multiple disciplines including the liberal arts, physics, geology, and science education. Results of the training were strongly positive as indicated by post-training anonymous survey results. During the second phase, students developed a total of 19 lesson plans. Examples of such topics include the societal impact of autonomous vehicles, transportation safety, and traffic flow.

Study Methods

Phase I – Training

All three faculty members involved in this project recruited students for the project. One faculty member trained the students in the art and science of lesson planning, with a special focus on incorporating Bloom's Revised Taxonomy (both the Cognitive Process and Knowledge dimensions) into the lesson planning process.

In all, seven students participated in the training, with one volunteering her time as an unpaid alternate. These students included the following:

1. Rabdeep Singh
2. Eric Madrigal
3. Na Xiong (alternate)
4. Victor Gonzales
5. Pa Yang
6. Savanna Havens
7. Stephon Squire

Training spanned two days from 10am–5pm and were conducted by John Walkup of the Department of Physics. Training sessions took place in the board room of the Department of Physics, McLane Hall 173. Topics included:

- Developing culminating activities with Depth of Knowledge,
- Establishing lesson content with the Knowledge Dimension of Bloom’s Revised Taxonomy,
- Selecting effective teaching strategies with the Cognitive Process Dimension of Bloom’s Revised Taxonomy, and
- Deploying effective questioning strategies using Depth of Knowledge.

The student team then developed lesson plans related to transportation issues under the guidance of a K-12 curriculum consultant and trainer (Walkup) and a transportation engineering expert (Tawfik).

The lesson planning method employs a step-wise procedure published in *The Art and Science of Lesson Planning* by John R. Walkup and published by Rowman & Littlefield.

Step 1: Establishing the Scope of the Lesson

Lesson planning starts out like most methods by outlining the chosen standard and topic. This process also includes a career focus into the learning objective.

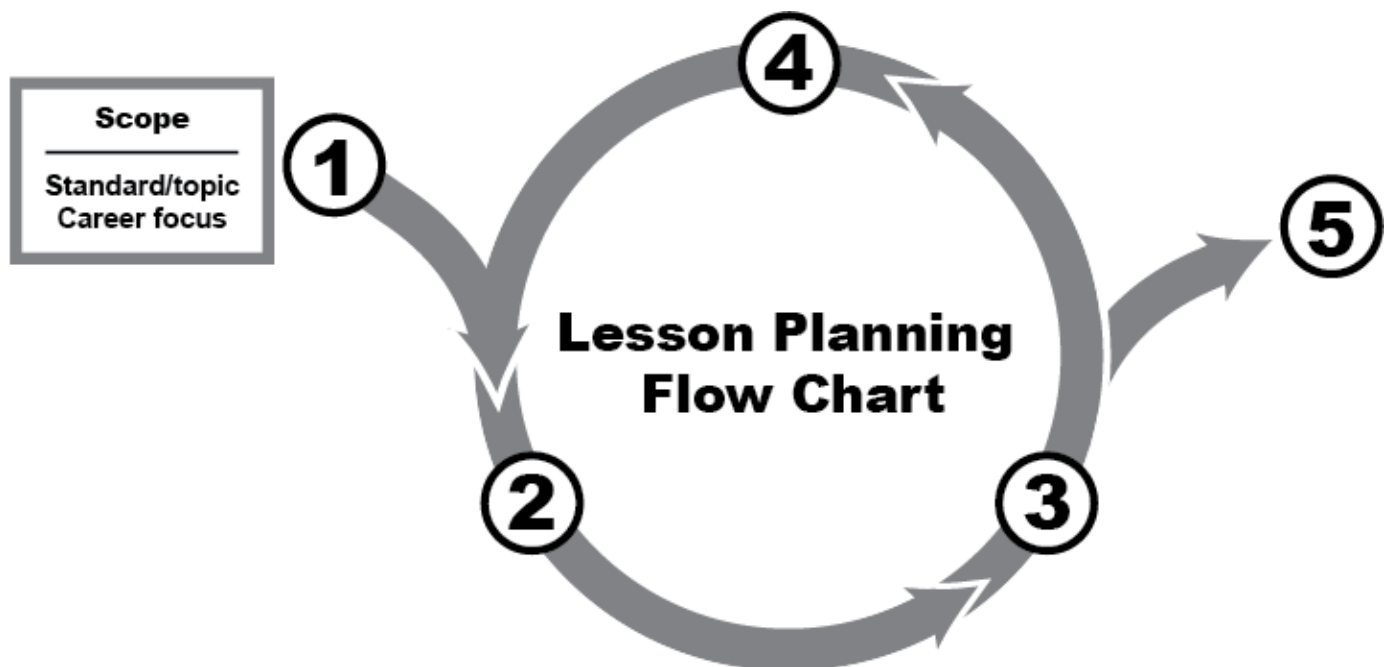


Figure 1. Step 1 of the lesson planning flow chart learned by FSTI trainees focuses on selecting a standard and career focus for the lesson

Step 2: Crafting a Culminating Activity Using Depth of Knowledge

The lesson plans developed by the student project team each feature a culminating activity aligned to one of the four Depth of Knowledge levels developed by Norman Webb displayed in Table 1 (Webb, 1997, 1999, 2005).

Table 1. Webb’s depth-of-knowledge (DOK) levels, where DOK-1 refers to Level 1 of Depth of Knowledge, and so on. (Webb 1997, 1999, 2005).

Level	Description
DOK-1	<i>Recall & Reproduction</i> — recall a fact, term, principle, or concept; perform a routine procedure.
DOK-2	<i>Basic Application of Skills/Concepts</i> — use information, conceptual knowledge; select appropriate procedures for a task; perform two or more steps with decision points along the way; solve routine problems; organize or display data; interpret or use simple graphs.
DOK-3	<i>Strategic Thinking</i> — reason or develop a plan to approach a problem; employ some decision-making and justification; solve abstract, complex, or non-routine problems, complex. (DOK-3 problems often allow more than one possible answer.)
DOK-4	<i>Extended Thinking</i> — perform investigations or apply concepts/skills to the real world that require time to research, problem solve, and process multiple conditions of the problem or task; perform non-routine manipulations across disciplines, content areas, or multiple sources.

Once trainees established culminating activities for their sample lessons, they learned to develop both a learning objective and language objective for the lesson.

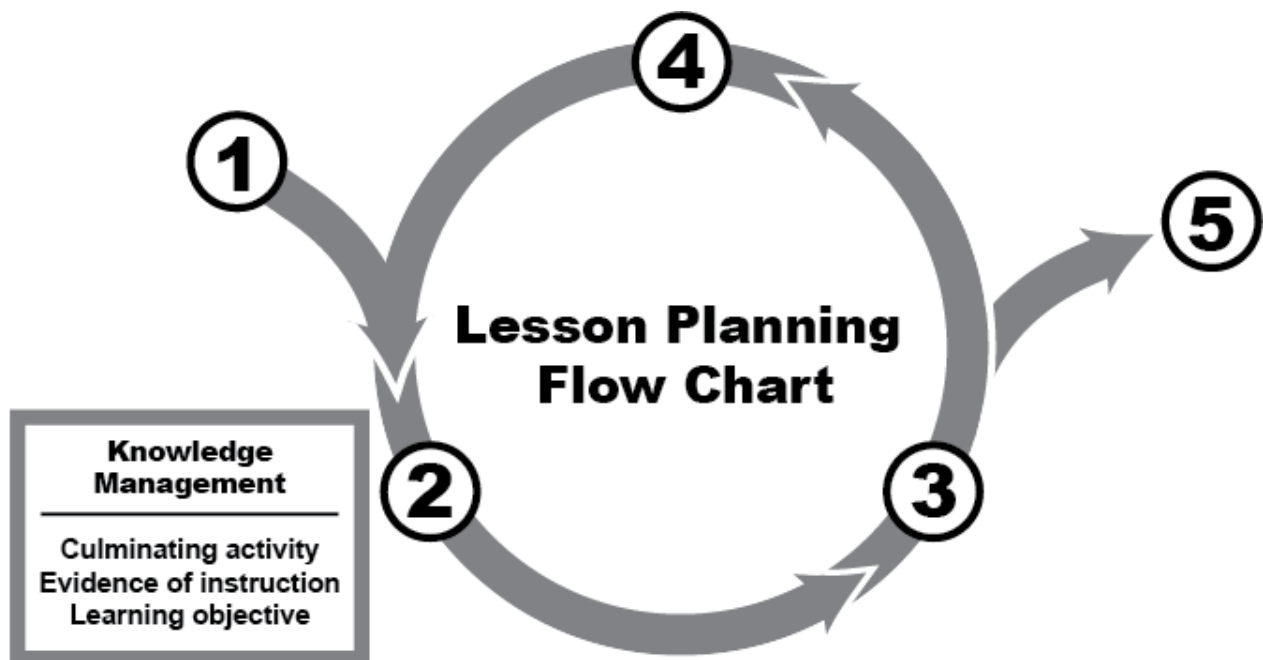


Figure 2. Step 2 of the lesson flow chart learned by FSTI trainees establishes the culminating activity to guide student participation

Step 3: Establishing Lesson Content with the Knowledge Dimension

Once a culminating activity was established, students in Step 3 use the Knowledge Dimension of Bloom’s Revised Taxonomy in Table 2, a mainstay of public school instruction, to establish the content of the lesson plans and to identify potential teaching strategies for delivering the lessons in the classroom. This step is shown in Figure 2.

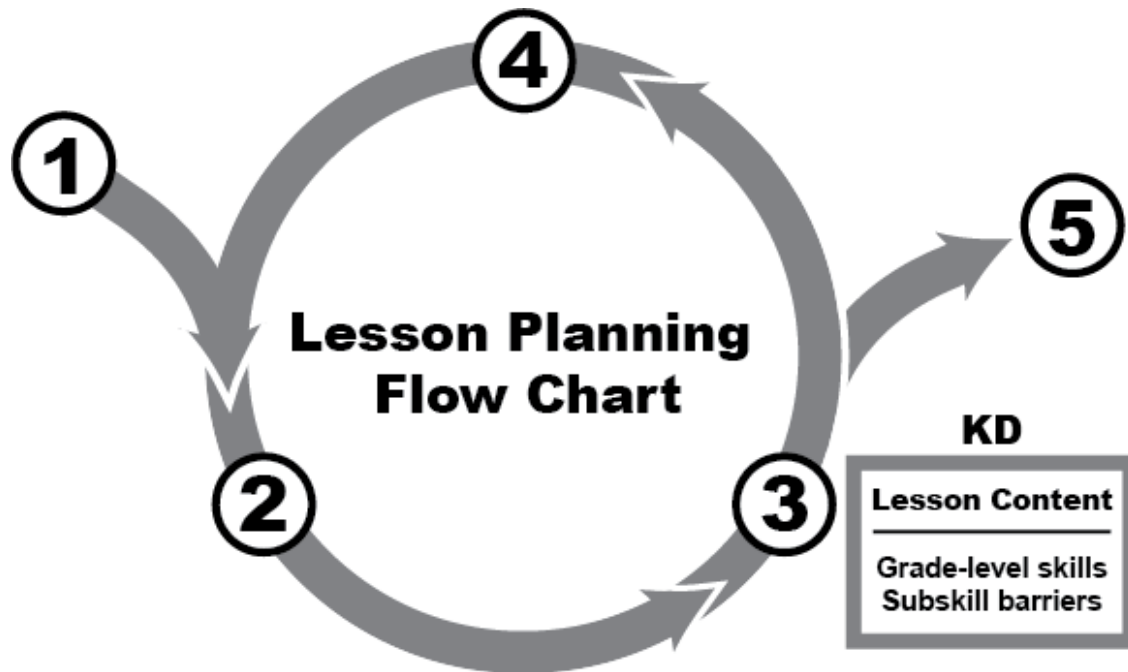


Figure 3. This chapter addresses Step 3 of the lesson flow chart, where we establish the lesson content

This step employs the use of modified version of the Knowledge Dimension of Bloom’s Revised Taxonomy shown in Table 2 (Anderson et al., 2001).

Table 2. Knowledge Dimension levels of the revised Bloom’s Taxonomy (Anderson et al., 2001)

Factual	Conceptual	Procedural	Metacognitive
Knowledge of terminology Knowledge of specific details and elements	Knowledge of classifications and categories Knowledge of principles and generalizations Knowledge of theories, models, and structures	Knowledge of subject-specific skills and algorithms Knowledge of subject-specific techniques and methods Knowledge of criteria for determining when to use appropriate procedures	Strategic knowledge Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge Self-knowledge

Step 4: Selecting Instructional Methods Using the Cognitive Process Dimension

For Step 4, trainees learned to identify potential instructional strategies for delivering the lesson content to students, as illustrated in Figure 3.

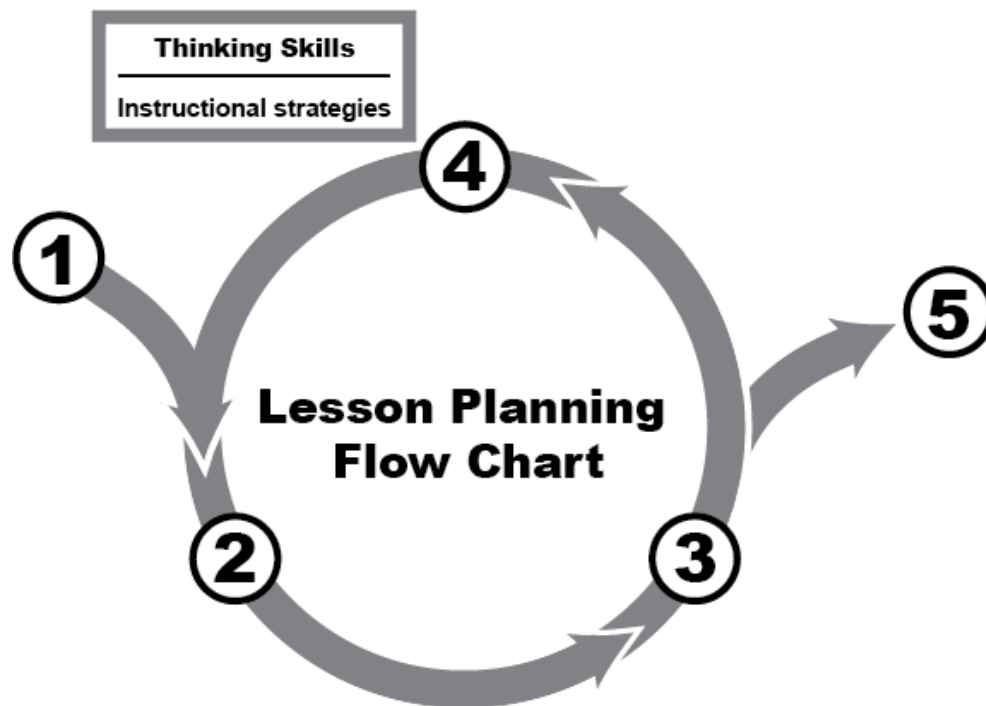


Figure 4. The lesson planning flow chart. This chapter focuses on Step 4.

This step leverages the Cognitive Process Dimension of Bloom’s Revised Taxonomy shown in Table 3 (Anderson et al., 2001).

Table 3. The Cognitive Process Dimension of Bloom’s Taxonomy and sample action verbs

Level	Description	Example verbs
Remember	Retrieve relevant knowledge from long-term memory	recognize, recall
Understand	Construct meaning from instructional messages, including oral, written, and graphic communication	explain, summarize, infer, classify, compare
Apply	Carry out or use a procedure in a given situation	execute, implement
Analyze	Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose.	differentiate, organize, attribute
Evaluate	Make judgments based on criteria and standards	check, critique
Create	Put elements together to form a coherent or functional whole; reorganize elements in to a new pattern or structure.	generate, plan, produce

Step 5: Developing Formative Assessment

In the final step of the lesson planning process, as shown in Figure 4, trainees learned to develop formative assessments for their lesson plans using a combination of Depth of Knowledge and the Cognitive Process Dimension of Bloom’s Revised Taxonomy.

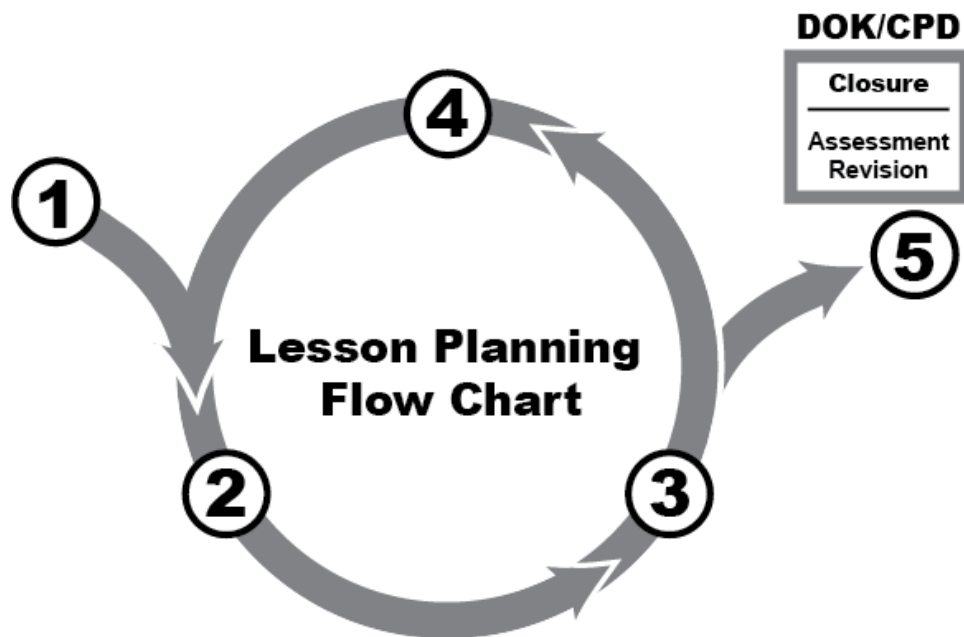


Figure 5. Step 5 of the lesson planning flow chart focuses on using Depth of Knowledge (DOK) and the Cognitive Process Dimension (CPD) of Bloom’s Revised Taxonomy to develop formative assessments for their lessons.

Phase II – Lesson plan Development

In Phase II of the project, students developed a total of 19 lesson plans for secondary school teachers.

The cadre of students changed, however, from Phase I. Two students expressed frustration at the arduous tasks involved in receiving payment for Phase I and decided not to participate in Phase II. Two students disenrolled from the university for personal reasons and were no longer living in the area. The project supervisor (Walkup) recruited additional students in response to these issues. Three of the students from an engineering course also agreed to participate. In all, the following students were involved in lesson plan development:

1. Rabdeep Singh (RS)
2. Eric Madrigal (EM)
3. Na Xiong (NX)
4. Lindsay Perales (LP)
5. Skylar Nguyen (SN)
6. Trenton Clutter (TC)
7. Zachary Carter (ZC)
8. Ammar Hanna (AH)

Students were first provided an online list of topics from which they could focus their lesson plan development. These selections included the following topics:

- Design of Class IV bike lanes
- Choice of fuel for school buses
- History of Ridge Route
- Traffic light coordination in SF
- Subsidization of hybrid vehicles
- Soil erosion on Highway 1
- Pros/cons of the High Speed Rail
- Effectiveness of ramp/signal lights
- Autonomous vehicles' effect on infrastructure
- Comparison of road surfacing materials
- Earthquakes and road construction
- Safety/efficiency of one-way streets
- Use of electric vehicles in rural towns
- Comparison of electric/diesel school buses
- Optimal timing of stoplights

A lesson plan template was provided for each student to complete. The lesson plan template included the following major sections, along with instructions:

- Author
- Subject
- Topic – choose one the topics listed on <https://bit.ly/35iNI1M>.
- Grade Level
- Knowledge and Performance Anchor Standards — copy/paste all those that apply from pp 2-6 of the CTE Transportation Standards.

- Transportation Pathway Standards — copy/paste all those that apply from pp 7-15 of the CTE Transportation Standards
- Other Standards — copy/paste all those that apply from pp 16-34 of the CTE Transportation Standards
- Career Focus — see pp. 4-6 of *The Art and Science of Lesson Planning*.
- Language Objective — see p. 17 of *The Art and Science of Lesson Planning*.
- Depth of Knowledge Level — see pp. xxi -- xxiii of *The Art and Science of Lesson Planning*.
- Culminating Activity — see Chapter 2 in *The Art and Science of Lesson Planning*.
- Anticipated Wait Time for Activity Prompt — see Table 6.4 of *The Art and Science Lesson Planning*.
- Grouping Strategy — see Table 6.4 of *The Art and Science Lesson Planning*.
- Resources — list any links useful for the teacher to deliver the lesson.
- Knowledge Dimension and Subskill Scaffolding — refer to the Knowledge Dimension of Bloom's Revised Taxonomy to complete this section. Discussion can be found in *The Art and Science of Lesson Design*.
 - Factual
 - Conceptual
 - Procedural
 - Relevance
 - Metacognitive
 - Communicative
 - Subskills
- Instructional Plan — refer to the Cognitive Process Dimension of Bloom's Revised Taxonomy to complete this section. Discussion can be found in *The Art and Science of Lesson Design*.
- Formative Assessment — complete the following table. Note that CFU and QFE refer to checking for understanding and questioning for engagement, respectively. Refer to pp. 77 -- 82 in *The Art and Science Lesson Planning* for instructions on how to create questions. For Wait Time and Grouping strategies, see Table 6.4 of *The Art and Science Lesson Planning*.

Findings

The training sessions conducted in Phase I were evaluated by the trainees in an online survey they completed once the sessions ended. Results are shown in the attached document.

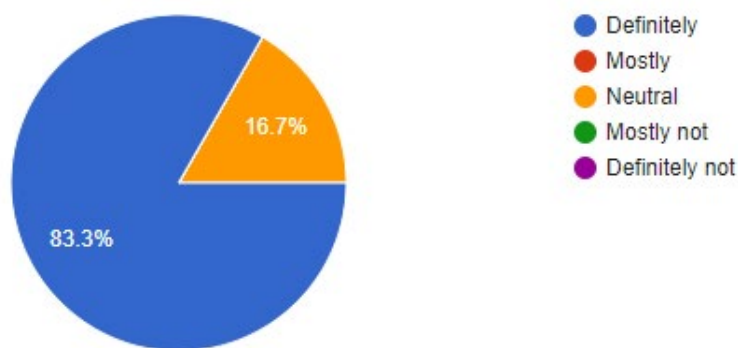
Table 4. Post-session survey results (anonymous)

	Responses				
	Definitely	Mostly	Neutral	Mostly not	Definitely not
The lesson planning training sessions presented material in a clear fashion.	66.7%	33.3%	0%	0%	0%
The lesson planning training sessions were engaging.	66.7%	16.7%	16.7%	0%	0%
The lesson planning training sessions effectively taught me many skills/ concepts I need to be a successful teacher.	66.7%	16.7%	16.7%	0%	0%
The lesson planning training sessions were worth my time and effort.	66.7%	16.7%	0%	0%	0%

Results of the survey are also illustrated in the pie chart show in Figure 6.

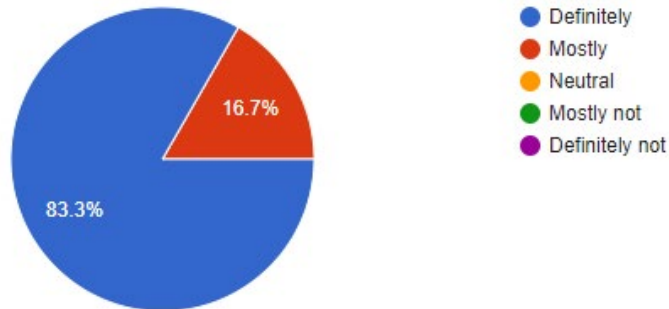
The lesson planning training sessions were worth my time and effort.

6 responses



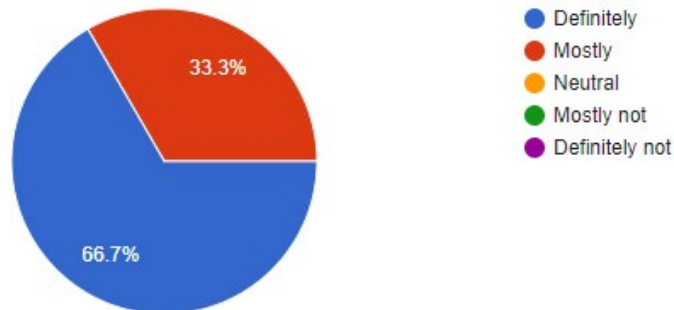
I would recommend others interested in teaching to participate in the lesson planning training sessions

6 responses



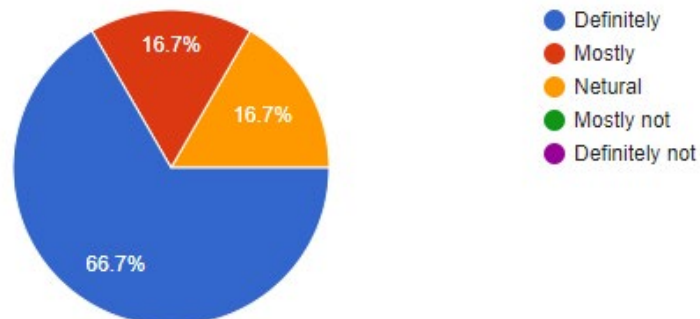
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6 responses



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6 responses



The lesson planning training sessions effectively taught me many skills/concepts I need to be a successful teacher.

6 responses

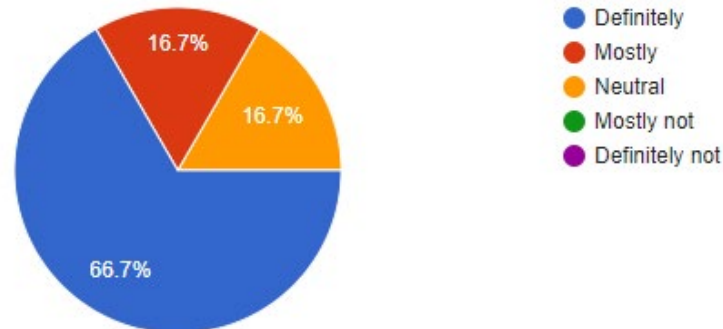


Figure 6. Post-training survey results

Conclusion

Results of the post-training survey indicate that future training sessions should (1) seriously consider the Cognitive Rigor 3-D approach to lesson planning and (2) adopt the training approach employed by Walkup to teach future teachers how to design effective K-12 lessons. Comments included:

- This is very beneficial, I wish other students/future teachers have more opportunities like this. Although we completed this in two days, I learned a lot and hope this type of workshop opens again over a period of one week or more.
- I have had a few other classes dealing future teachers and none of them were are [sic] helpful or effective as the training. In terms of lesson planning I learned more from the training than any other class.
- The lesson plan training was intensive yet highly informative. I learned more in this two-day training than I have in semester long course. It would be in the university's best interest to implement lesson plan preparation as explained in this training in the Kremen School of Education,
- I was amazed by the bloom level and the grapple method. Teaching by using this method seem more efficient than most of the time when teacher just talk.

Abbreviations and Acronyms

CPD	Cognitive Process Dimension of Bloom's Revised Taxonomy
DOK	Depth of Knowledge
KD	Knowledge Dimension of Bloom's Revised Taxonomy

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Acknowledgements

The authors thank Lisa Rose, for editorial services, as well as MTI staff, including Executive Director Karen Philbrick, PhD; Deputy Executive Director Hilary Nixon, PhD; Graphic Designer Alverina Eka Weinardy; and Communications and Operations Manager Irma Garcia.

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Dr. Singleton is a full professor and Chair of the Fresno State Physics Department and one of the leading architects of his department's student research programs. Over the past 20 years at Fresno State, Dr. Singleton has led more student research programs and collaborations than any other professor in his department. Such activity includes serving as thesis advisor for 15 physics students and the publication of over 40 articles in leading science journals.

Dr. John Walkup is a pioneer in the classroom use of Cognitive Rigor, the superposition of Bloom's Revised Taxonomy and Depth of Knowledge. He is also an educator, having taught at the Oklahoma School of Science & Mathematics (one of the most successful K-12 magnet schools in the U.S.) and six universities including his current stint as Lecture at Fresno State.

This report can be accessed at
transweb.sjsu.edu/research/1914



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