Improving Inclusive Science Teachers' Vocabulary Instruction: A Multimedia-Based Professional Development Process

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Early Career Research & Development

Rationale

- Students with disabilities (SWD) often struggle in secondary-level science courses (NCES, 2015)
- A possible reason is the **highly technical vocabulary** (Bryant et al., 2002; Kennedy, Rodgers, et al., 2017)
- Interventions and instructional routines addressing vocabulary needs in general and special education are plentiful (e.g., Mastropieri et al., 1998; Mastropieri & Scruggs, 1992; Mastropieri et al., 1999; Mastropieri et al., 2006; Scruggs et al., 1998; Therrien, et al., 2011), but needs remain
- General education is where almost all students access the science curriculum (Vannest et al., 2009) but science educators often **lack training** and **report feeling underprepared** to address the unique needs of SWD in inclusive settings (Robinson, 2002; Wei et al., 2010)
- The majority of work in science education addressing the needs of SWD is curricular; **examinations of how to change teacher practice are not prevalent**
- If inclusive science teachers can improve vocabulary and concept instruction, it may lead to SWD readiness to succeed within inquiry activities and science assessments

Research Questions

1.) To what extent does participation in the Content Acquisition Podcast Professional Development (CAP-PD) process improve inclusive science teachers' **quality and quantity of high quality vocabulary instruction**?

2.) Do students in classes where teachers have received the CAP-PD (CAP-TV + CAP-TS + CT Scan coaching) demonstrate **higher levels of achievement** on researcher created CBM of science vocabulary knowledge and standardized measures of content knowledge?

Methods

Study 1 (2015-16)

- **N = 3** inclusive middle school science teachers (from a rural school)
- Single case multiple baseline design
- What Works Clearinghouse Standards Met (Minimum 5 points in each phase, randomly assigned teachers to starting positions)

Treatment

- After baseline, teachers received full CAP-PD in staggered fashion. Coaching emails were provided daily for the duration of the intervention period

Study 2 (2016-17)

- **N = 28** inclusive middle school science teachers (all from rural schools)
- Randomly assigned to condition (T = **14**, C = **14**)
  - Three baseline and three intervention observations
- **N = 1,781** students, **14.1%** Students with IEPs

"Underpowered" RCT

Variables of Interest and Data Collection

- Teacher Practice: (Both studies)
  - **Frequency, duration, and implementation fidelity of vocabulary EBPs** (CT Scan; Kennedy et al., **2017**)
- Student achievement: (Study 2 only)
  - Researcher created vocabulary CBM: **Three probes throughout intervention**
  - Standardized science content knowledge (MOSART; Sadler et al., 2010): **Given at Pre and Post**

Treatment

- After baseline, teachers in treatment were provided with full CAP-PD; teachers in comparison condition were provided with the CAP-TS curricular support alone

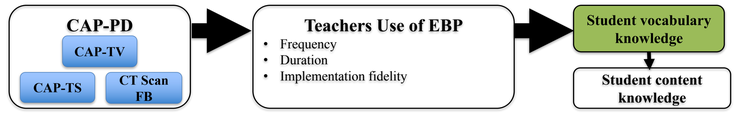
Conceptual Framework and Intervention

Cognitive Apprenticeship (Collins, Brown, & Newman, 1989)

- Multi-faceted approach addresses the **content, methods, sequencing, and sociology of learning**
- Core components (modeling, coaching, scaffolding) have considerable support in professional development literature (Darling-Hammond et al., 2017; Kraft et al., 2017)

CAP-PD Adaptation:

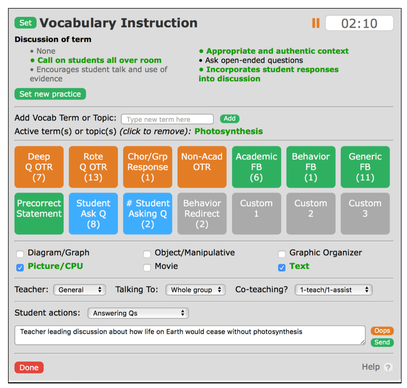
- **Modeling** (**CAP-TV**: multi-media vignettes with embedded modeling videos to boost declarative, conditional and procedural knowledge; Alexander, Schallert, & Hale, 1991)
- **Coaching** (**CT Scan**: low-inference instrument that records teacher moves in real time; generates descriptive feedback based on observational data)
- **Scaffolding** (**CAP-TS**: content-based slides that use practices modeled in CAP-TV. CAP-TS are example of educative curriculum materials; Davis & Krajcik, 2005)



CT Scan & Visual Outputs

Kennedy, Rodgers, & Romig (2015) www.classroomteachingscan.com/ctscan/

Interface



Data Outputs

Results: Study 1

Kennedy, Rodgers et al., 2017; *Journal of Teacher Education 68*(2), 213-230

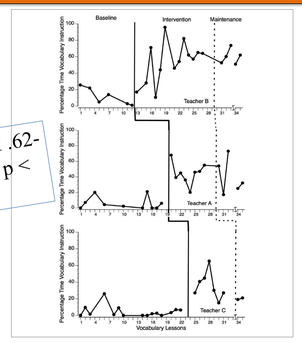


Figure 4. Graphs showing the percentage of time per class spent in explicit vocabulary instruction.

Tau = .95, 95% CI .62-1.28 (z = 5.601, p < .001)

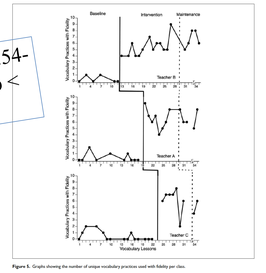


Figure 5. Graphs showing the number of unique vocabulary practices used with fidelity per class.

Tau = .87, 95% CI .54-1.21 (z = 5.166, p < .001)

Results: Study 2

Quality Vocabulary Index

$$QVI = \sum \left((x+1)\frac{y}{z} \right)_{ij}$$

Where x is the percent of fidelity for a given practice, y is the duration (seconds) that the teacher demonstrated the given practice, and z is the duration (seconds) of the lesson.

Practice	% Implementation Markers	Duration (seconds)
Student friendly definitions	50%	300
Examples	75%	600
Morphological analysis	100%	180
Semantic feature analysis	0%	120

$QVI = ((.50+1)\frac{300}{3600}) + ((.75+1)\frac{600}{3600}) + ((1.0+1)\frac{180}{3600}) + ((.00+1)\frac{120}{3600})$

$QVI = 0.125 + 0.292 + 0.1 + .033$

$QVI = 0.55$

Researchers conducted 158 observations totaling 8,767 minutes (55.8 minutes per lesson). All observations were completed using the CT Scan. The three baseline observations occurred in relatively close proximity in the first month of school. The three post-observations occurred approximately once per month, spread across the fall semester.

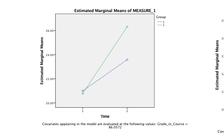
	Full CAP-PD	CAP-TS Only	Group Comparison
Baseline	*N* = 38 Observations	*N* = 39 Observations	
Avg. QVI Per Lesson	*M* = .2460 (.321)	*M* = .2724 (.301)	$F(1, 75) = .138$, $p = .711$
Avg. # of Questions Per Lesson	*M* = 30.1 (25.0)	*M* = 33.8 (25.8)	$F(1,75) = .422$, $p = .518$
Avg. # of Feedback Statements Per Lesson	*M* = 11.7 (9.5)	*M* = 11.7 (9.5)	$F(1, 75) = .633$, $p = .429$
Avg. # of Minutes Off-Task Per Lesson	*M* = 22.1 (11.8)	*M* = 25.9 (15.8)	$F(1, 75) = 1.44$, $p = .234$
Avg. Minutes of Instruction Per Lesson	*M* = 29.2 (14.8)	*M* = 26.3 (19.9)	$F(1, 75) = .544$, $p = .463$
Avg. Minutes of Vocab Per Lesson	*M* = 9.5 (10.3)	*M* = 8.2 (13.3)	$F(1, 75) = .207$, $p = .650$

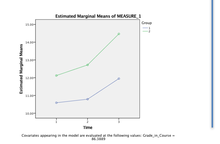
	Full CAP-PD	CAP-TS Only	Group Comparison
Post-Intervention	*N* = 40 Observations	*N* = 40 Observations	
Average QVI Per Lesson	*M* = .9035 (.377)	*M* = .5117 (.465)	$F(1, 78) = 17.2$, $p < .001$, $d = .93$
Average # of Questions Per Lesson	*M* = 51.2 (27.5)	*M* = 30.2 (16.8)	$F(1,76) = 16.7$, $p < .001$, $d = .92$
Average # of Feedback Statements Per Lesson	*M* = 25.7 (15.5)	*M* = 14.8 (10.7)	$F(1, 76) = 13.1$, $p = .001$, $d = .82$
Average Minutes Off-Task Per Lesson	*M* = 17.5 (9.9)	*M* = 26.5 (15.7)	$F(1, 76) = 9.14$, $p = .003$, $d = .69$
Average Minutes of Instruction Per Lesson	*M* = 42.3 (15.1)	*M* = 33.1 (14.6)	$F(1, 76) = 7.51$, $p = .008$, $d = .62$
Average Minutes of Vocab Per Lesson	*M* = 29.5 (13.5)	*M* = 15.9 (11.6)	$F(1, 75) = 22.9$, $p < .001$, $d = 1.08$

Students completed the MOSART Astronomy, Life Science and Physical Science Assessments as a Pre- and Posttest. They also completed three vocabulary CBMs; approximately once per month.

All Students

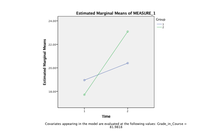
	Full CAP-PD	CAP-TS Only	Group Comparison
Baseline	*N* = 873 Average GPA: 86.3	*N* = 888 Average GPA: 85.9	
MOSART Space	*M* = 5.0 (2.4)	*M* = 4.8 (2.5)	$F(1, 1759) = 3.1$, $p = .080$
MOSART Life	*M* = 10.1 (4.6)	*M* = 10.6 (4.6)	$F(1, 1759) = 5.9$, $p = .016$
MOSART Physical	*M* = 5.7 (2.8)	*M* = 6.0 (2.7)	$F(1, 1759) = 3.7$, $p = .056$
MOSART Total	*M* = 20.8 (7.9)	*M* = 21.5 (7.8)	$F(1, 1758) = 3.1$, $p = .077$
Post Intervention	*N* = 876	*N* = 781	
MOSART Space	*M* = 6.4 (2.8)	*M* = 5.8 (2.8)	$F(1, 1655) = 24.0$, $p < 001$, $d_{pjc2} = .18$
MOSART Life	*M* = 13.6 (4.5)	*M* = 11.6 (4.6)	$F(1,1655) = 85.5$, $p < .001$, $d_{pjc2} = .54$
MOSART Physical	*M* = 6.6 (3.6)	*M* = 6.1 (2.8)	$F(1, 1655) = 9.7$, $p = .002$, $d_{pjc2} = .26$
MOSART Total	*M* = 26.4 (7.9)	*M* = 23.5 (7.7)	$F(1, 1655) = 59.0$, $p < .001$, $d_{pjc2} = .46$
Curriculum-Based Measures			
CBM 1	*M* = 12.1 (3.7)	*M* = 10.4 (3.8)	$F(1, 1679) = 83.9$, $p < .001$, $d = .43$
CBM 2	*M* = 12.8 (3.5)	*M* = 10.7 (3.8)	$F(1, 1672) = 127.5$, $p < .001$, $d = .57$
CBM 3	*M* = 14.5 (3.3)	*M* = 11.9 (3.8)	$F(1, 1591) = 213.6$, $p < .001$, $d = .73$

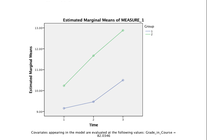




Students with IEPs

	Full CAP-PD	CAP-TS Only	Group Comparison
Baseline	*N* = 132 Average GPA: 82.5	*N* = 119 Average GPA: 80.8	
MOSART Space	*M* = 4.4 (2.3)	*M* = 4.4 (2.1)	$F(1, 249) = .067$, $p = .796$
MOSART Life	*M* = 8.8 (4.2)	*M* = 8.9 (4.2)	$F(1, 249) = .079$, $p = .778$
MOSART Physical	*M* = 4.9 (2.4)	*M* = 5.2 (2.3)	$F(1, 249) = .958$, $p = .329$
MOSART Total	*M* = 17.8 (6.9)	*M* = 18.5 (6.7)	$F(1, 249) = .517$, $p = .473$
Post Intervention			
MOSART Space	*M* = 5.9 (2.7)	*M* = 5.0 (2.5)	$F(1, 238) = 8.1$, $p = .005$, $d_{pjc2} = .47$
MOSART Life	*M* = 11.9 (4.3)	*M* = 9.7 (4.8)	$F(1,238) = 14.1$, $p < .001$, $d_{pjc} = .55$
MOSART Physical	*M* = 5.8 (3.7)	*M* = 5.4 (2.7)	$F(1, 238) = .894$, $p = .345$, $d_{pjc2} = .29$
MOSART Total	*M* = 23.3 (7.4)	*M* = 20.1 (8.0)	$F(1, 238) = 9.8$, $p = .002$, $d_{pjc} = .54$
Curriculum-Based Measures			
CBM 1	*M* = 10.3 (3.5)	*M* = 9.1 (3.5)	$F(1, 240) = 6.5$, $p = .011$, $d = .33$
CBM 2	*M* = 11.9 (3.4)	*M* = 9.3 (3.6)	$F(1, 239) = 31.5$, $p < .001$, $d = .73$
CBM 3	*M* = 13.0 (3.5)	*M* = 10.4 (3.5)	$F(1, 228) = 28.2$, $p < .001$, $d = .70$





Teacher & Student Mean Data Organized by QVI

Teacher	93	32	92	42	112	113	31	12	61	71	91	34	52	41	21	73	101	51	62	74	72	35	11	43	33	102
QVI	1.35	1.33	1.3	1.15	1.12	1	1	0.95	0.94	0.98	0.76	0.75	0.74	0.73	0.71	0.65	0.6	0.51	0.44	0.39	0.36	0.29	0.25	0.17	0.09	0
Group	1	2	2	2	1	2	2	2	2	2	2	2	2	1	2	1	1	1	1	1	1	1	1	1	1	1
MOSART Post	25.2	30.2	25.2	25.2	24.9	27.6	29.6	25.2	27.6	19.7	27.3	26.8	31.7	22.8	29.3	21.2	23.3	22.2	23.2	21	23.9		21.6	24.5	24.1	23.4
CBM1	11.9	12.4	11.2	15.1	10.5	12.8	13.5	12.4	11	12.9	12.8	11.2	12	13	12.7	8.4	10.2	10	7.5	10	10.7	9.8	12.5	9.8	9.3	9.8
CBM2	12.7	14.4	12.5	13.1	10.7	13.2	14.4	13.7	13.9	13.8	13.7	9.5	12.2	11.1	14.7	7.7	11.1	10.4	11.3	10	12.4	10.4	12.9	9	10.1	9.9
CBM3	14.5	15.3	15.7	14.1	13.3	15.4	15.4	14.9	14.9	14.8	14.9	12.2	14.6	12.1	15.3	9.8	12.6	10.5	10.2	10.6	12.8		11.5	11.7	11.5	10.6