NEBRASKA CENTER FOR RESEARCH ON CHILDREN, YOUTH, FAMILIES & SCHOOLS

2021 IES Grant Essentials: Session 5

Cost & Cost-Effectiveness Analyses: What, Why and How?

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Outline

- Overview of Economic Evaluation
- Cost Analysis
- Cost-Effectiveness Analysis
- Considerations for Federal Grant Proposals
- General Recommendations and Resources
- Simplified Hypothetical Example

Acknowledgement

- Concepts presented in Sections 1-3 of this session come from the following source:

  Levin, H. M., McEwan, P. J., Belfield, C., Bowden, A. B., & Shand, R. (2018). *Economic evaluation in education: Cost-effectiveness and benefit-cost analysis* (3rd ed.). Thousand Oaks, CA: SAGE Publications.

Overview of Economic Evaluation

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Types of Evaluations

Type	Goal	Questions Addressed	Limitations
*Cost Analysis	Estimate cost of program implementation	• Is this program affordable? (cost feasibility analysis) • Who finances the costs? • Which program components are most costly? • How scalable is the program? • How variable are costs across sites?	• No consideration of program outcomes
*Cost-Effectiveness (CE) Analysis	Estimate incremental cost to achieve 1-unit increase in effectiveness, relative to an alternative program with common goals	• Given a fixed budget, is this program more effective than other programs that target the same outcome? • Given a required level of effectiveness, is this program less costly than other programs that target the same outcome?	• Limited to relative conclusions • Alternative programs must target the same outcome
Benefit-Cost (BC) Analysis	Estimate a program's monetized effects (benefits) relative to its monetized costs	• Do the returns on this program justify its costs? • Is this program a more "socially desirable investment" than alternative programs that target the same or different outcomes?	• Can be difficult to monetize impacts • Long-term benefits generally require projection

*Focus of this session

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Cost Analysis

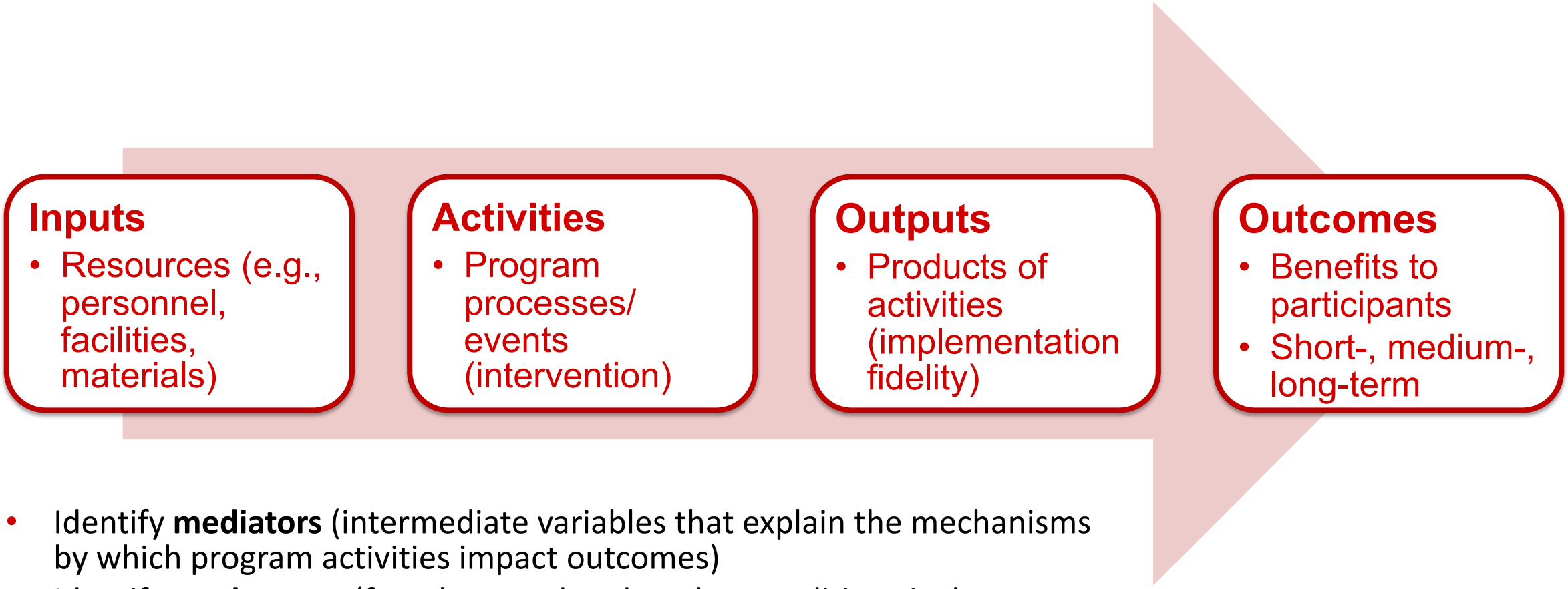
How are Program Costs Defined?

- "All the resources that are involved in 'making the intervention work'" (p. 51; Levin et al., 2018)
  - Start-up costs
  - Maintenance costs
  - Indirect costs
  - Induced costs (e.g., Bowden et al., 2017)
  - Does not include costs of research
- The "Ingredients Method" is a systematic framework for estimating costs that relies on the concept of "opportunity cost" (the value of a resource is its next best use)

Steps for Performing a Cost Analysis

1. Operationalize the program's theory of change (TOC)
2. Define the parameters of the evaluation (purpose, timeline, audience, perspective)
3. Identify the program's ingredients and their characteristics
4. Price the ingredients
5. Calculate costs
6. Conduct sensitivity analyses
7. Report the results

Step 1: Develop Logic Model to Operationalize TOC



- Identify **mediators** (intermediate variables that explain the mechanisms by which program activities impact outcomes)
- Identify **moderators** (for whom and under what conditions is the program expected to improve outcomes)

IES (2020)

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Step 2: Identify Purpose of Evaluation

- Evaluate one program vs. compare multiple programs?
- Calculate total costs vs. incremental costs?
- Consider costs only vs. costs and outcomes (effects/benefits)?

Step 2, cont'd: Specify Timeline for Evaluation

- The cost analysis should consider all program costs incurred up to the time at which the outcomes are measured
  - Short- vs. long-term outcomes
  - Induced costs
- Multi-year evaluations can help distinguish start-up from maintenance costs

Step 2, cont'd: Identify Audience(s)

- Funding agencies, state and district agencies, practitioners, parents, researchers, general public/taxpayers, etc.
- Primary (client) vs. secondary audiences
- Local vs. regional vs. national audiences

Step 2, cont'd: Identify Perspective

- *Societal perspective
  - Consider all costs, regardless of who finances the costs
  - Can still disaggregate results by constituency
- Individual perspective
  - Focus only on costs incurred by the participants (household/family)
- Fiscal perspective
  - Focus only on costs incurred by a particular stakeholder (e.g., state or district agency, school)

Step 3: Identify Ingredients

- Personnel (e.g., teachers, volunteers, coaches, parents, adult participants)
- Facilities (e.g., classroom space)
- Equipment/materials (e.g., computers, software, internet, training manuals)
- Other program inputs (e.g., transportation)

Step 3, cont'd: Detail Properties of Ingredients

- Qualifications (e.g., education level/certifications, experience)
- Dimensions/characteristics (e.g., sq ft, safety requirements, furnishings, amenities)
- Dosage/quantity (e.g., number, % FTE, % usable time allocated to program)

Step 3, cont'd: Sample Ingredients Data

- Program descriptions, budgets, and expenditure reports provide a starting point, but are generally insufficient
  - Lack precise information about ingredients' properties
  - May not capture all resources (e.g., volunteer time)
  - Describe intended resources, not necessarily actual resources
  - Fail to capture site-by-site variability
- Cost data should be sampled from implementation sites
  - Perform concurrently with program implementation/efficacy study
  - Use traditional data collection methods (e.g., surveys, logs, interviews, observation)

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Step 4: Price Ingredients

- If feasible, both local (site-specific) and national (expected) prices should be considered
- Local prices are subject to greater sampling error and are less generalizable, but are more meaningful to local stakeholders
- National prices are more generalizable and thus inform the field more broadly, but may not always be available
- Separate cost analyses should be performed for local vs. national prices (i.e., prices should not be mixed)

Step 4, cont'd: Estimate National Prices

- Search *CostOut* (Hollands, Hanisch-Cerda, Levin et al., 2015), a free online tool kit developed by the Center for Benefit-Cost Studies (CBCSE) that has a multi-source database with national market prices
- Review national surveys/reports
  - U.S. Bureau of Labor Statistics
  - National Association of Realtors
  - National Center for Education Statistics
- Search Amazon
- Convert local prices to national prices by applying a geographic price index (available in *CostOut*)

Step 4, cont'd: Estimate Local Prices

- Review expenditure reports
- Search publicly available salary databases/schedules
- Consult local realtors
- Convert national prices to local prices by applying a geographic price index (available in *CostOut*)

Step 4, cont'd: Estimate Shadow Prices

- Some resources do not have a competitive market price
  - Parent volunteer time
  - Facilities that are loaned to a program
- Shadow prices are needed in the absence of market prices and are estimated as the value of the ingredient's next best use (i.e., its opportunity cost)
  - Market price (salary and fringe benefits) of someone hired to carry out the volunteer activities
  - Rental fees

Step 5: Calculate Costs

- Cost of ingredient = price x quantity: $C_i = P_i \times Q_i$
- Total cost of program implementation = sum of all costs: $\mathrm{C} = \sum_i C_i$
- Average cost per program participant = total cost divided by the number of program participants: $\overline{C} = C/N$
- Incremental cost = cost of target program minus cost of alternative program: $\overline{C}_T - \overline{C}_A$
- Marginal cost = cost of distributing the program to one additional participant

Steps 4-5: Adjust for Inflation

- Costs incurred in later years of a multi-year evaluation may be greater due to inflation
- Market prices may be derived from different sources that use data from different years
- Need to base all prices on a common year by converting unadjusted prices (P) to adjusted prices (AP):

$$AP = P \times (IE / IP)$$

where IE = price index for year corresponding to AP and IP = price index for year corresponding to P (see U.S. Bureau of Labor Statistics for rates)

Hollands, Hanisch-Cerda, Menon et al. (2015)

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Steps 4-5: Adjust for Geographic Location

- May need/want to convert between local or regional prices/costs and national prices/costs
- Similar to adjusting for inflation
- Base all prices on a common location by converting existing price (P) to geographically adjusted price (GP):

$$GP = P \times \left(RPP_e / RPP_p \right)$$

where RPP_e and RPP_p are the Regional Price Parities corresponding to GP and P, respectively

Hollands, Hanisch-Cerda, Menon et al. (2015)

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Steps 4-5: Discount Future Costs

- In multi-year evaluations, future costs are preferred to immediate costs
- Need to express all future costs in terms of present value (PV):

$$PV = P \times e^{D \times (1-Y)}$$

where P is the price of the ingredient, Y is the year the ingredient was used, and D is the discount rate (default in *CostOut* is 3.5%)

Hollands, Hanisch-Cerda, Menon et al. (2015)

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Steps 4-5: Amortize Costs

- Some assets (facilities, equipment, training) have a lifetime > 1 year
- If costs are based on yearly rental rates, then no adjustments are required
- Otherwise, need to distribute costs across the life of the asset while adjusting for interest and depreciation:

$$AC = P \times \frac{R \times (1+R)^L}{(1+R)^L - 1}$$

where AC = annual cost, P = purchase or replacement price, R = interest rate (default in *CostOut* is 3.5%), and L = life of asset in years

Hollands, Hanisch-Cerda, Menon et al. (2015)

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Step 6: Test Parameter Sensitivity

- “The choice of parameters for further investigation should be motivated by three criteria: which parameter is the ‘largest’; which parameter is the most influential; and which parameter is the most controversial” (p. 251; Levin et al., 2018)
- Consider alternative prices
- Consider alternative quantities/qualities/characteristics of ingredients
- Test different assumptions (e.g., different discount rates)
- Consider other debatable costs/ingredients

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Step 7: Report Costs

- Tailor according to purpose, audience, and perspective
- Provide aggregated information (e.g., average cost)
- Provided disaggregated information where meaningful
  - constituency (highlight who finances the costs)
  - site (identify site-by-site variability)
  - ingredient (inform scalability)
  - year (distinguish start-up from maintenance costs)
- Report worst-case/best-case scenario based on sensitivity analyses
- Report standard errors if appropriate

Cost-Effectiveness Analysis

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Steps for Performing a Cost-Effectiveness Analysis

1. For *all* programs under evaluation, *concurrently* estimate program costs and impacts (effects)
2. Calculate cost-effectiveness ratios (CERs)
3. Conduct sensitivity analyses
4. Compare and rank alternative programs

Step 1: Estimate Costs and Impacts

- Follow cost analysis steps to estimate costs
- Program impacts (effectiveness) are defined by the theory of change and are the primary outcomes measured in the efficacy study
- Follow standard guidance for carrying out efficacy study
- Calculate standardized effects to facilitate interpretation

Step 2: Calculate CERs

- CERs indicate the *incremental* cost (C) per participant needed to achieve a 1-unit increase in effectiveness (E) per participant, relative to an alternative program with common goals
- $\mathrm{CER} = (C_T - C_A)/(E_T - E_A) = (\Delta C)/(\Delta E)$
- Alternative may be business-as-usual (BAU) or a different program
- When comparing more than two programs need to use a common reference group (e.g., BAU)

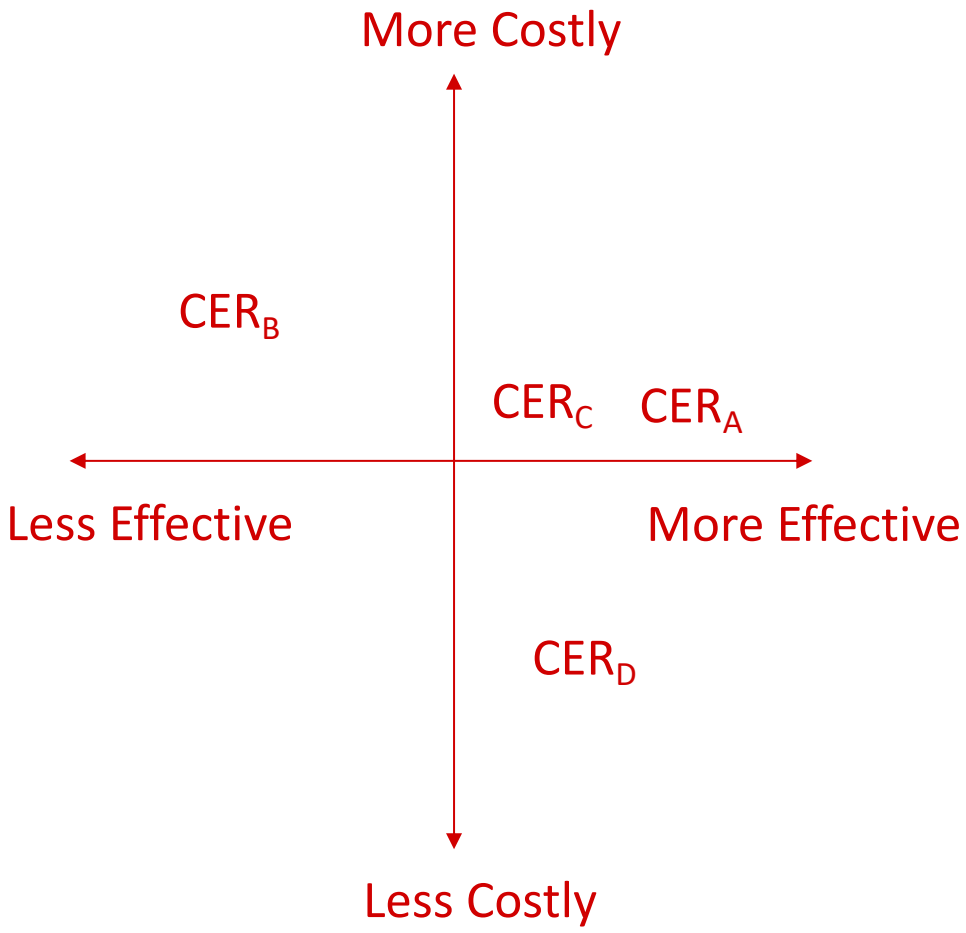
Step 3: Conduct Sensitivity Analyses

- Examine how CERs vary as a function of different cost assumptions
- Examine how CERs vary as a function of different effect assumptions (e.g., different models)

Step 4: Compare and Rank Alternative Programs

- Smaller CERs are generally preferable
- Need to consider
  - sign of ΔC and ΔE
  - magnitude of C_T and C_A, and E_T and E_A, in relation to budget restrictions or minimum desired effectiveness
  - heterogeneity in CERs (e.g., across sites, participant groups)

Step 4, cont'd: Create Cost-Effectiveness Map



- Origin represents baseline comparison group
- Southeast quadrant is optimal (more effective and less costly)
- Northeast quadrant is more likely (more effective and more costly)

Considerations for Federal Grant Proposals

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Proposing an Economic Evaluation

- Read the RFA!
  - Identify the type of evaluation that is required/recommended
  - Instructions vary across different project types within the same RFA, and vary across years
- You are NOT expected to have already estimated the program costs or identified all of the program's ingredients at the time of the proposal
- You ARE expected to describe the guiding framework and procedures that will allow you to obtain this information
- Distinguish projected costs from actual costs: you still need to carry out a cost analysis even if you already have an estimate of the cost
- Distinguish costs from who finances the costs: you still need to carry out a cost analysis even if you intend to offer the program for "free"

See IES (2020)

Proposing an Economic Evaluation, cont'd

- Reference "Ingredients Method" and TOC as guiding frameworks
- Specify audience(s) and (preferably) adoption of a societal perspective
- Describe plan for identifying ingredients and their features and assigning prices
  - Data collection tools
  - Concurrent with program implementation/efficacy study
  - (Preferably) national and local prices
  - Address complexities (e.g., shadow pricing for parent volunteer time, pricing adjustments for multi-year evaluations)
  - Follow same procedures for comparison program(s)
- Specify how costs will be calculated (e.g., total vs. incremental) and presented/disaggregated
- Describe plan for conducting sensitivity analyses

Proposing an Economic Evaluation, cont'd

- Include economic evaluation activities in timeline
- Identify key personnel who will oversee and carry out the economic evaluation
  - Describe their relevant expertise
  - Make sure to budget sufficient funds (sufficient FTE) to carry out the evaluation

General Recommendations and Resources

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General Recommendations

- Be transparent
- Be consistent
- Err on the side of being conservative
- Follow the principle of proportionality

Levin et al. (2018)

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Useful Resources

- *Institute of Education Sciences (IES). (2020). *Cost Analysis: A Toolkit* (IES 2020-001). U.S. Department of Education. Washington, DC: Institute of Education Sciences. Retrieved May 21, 2021 from https://ies.ed.gov/seer/pdf/IES_Cost_Analysis_Starter_Kit_V1.pdf
- *Levin, H. M., McEwan, P. J., Belfield, C., Bowden, A .B., & Shand, R. (2018). Economic evaluation in education: Cost-effectiveness and benefit-cost analysis (3rd ed.). Thousand Oaks, CA: SAGE Publications.
- Center for Benefit-Cost Studies of Education (CBCSE) website: https://www.cbcse.org/
- *CostOut*, free online tool created by CBCSE (funded by IES) (Hollands, Hanisch-Cerda, Levin et al., 2015; Hollands, Hanisch-Cerda, Menon et al., 2015)
- Recordings from an IES-funded workshop on economic evaluation led by CBCSE (https://www.youtube.com/channel/UC6K9RPekvxN4DewxX1oi8jA)
- *Crowley, D. M., Dodge, K. A., Barnett, W. S., Corso, P. Duffy, S., Graham, P. Greenberg, M., Haskins, R., Hill, L., Jones, D. E., Karoly, L. A., Kuklinski, M. R., & Plotnick, R. (2018). Standards of evidence for conducting and reporting economic evaluations in prevention science. Prevention Science, 19(3), 366-390.

*Provide checklists for economic evaluation

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Simplified Hypothetical Example

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Hypothetical Evaluation (HYPE)

- HYPE is an individually administered intervention aimed at improving reading achievement among K-2 students with reading difficulties
- 100 students across 25 teachers and 5 schools were randomly assigned to 1 of 2 groups: HYPE or BAU

Parameters of Evaluation

- Purpose
  - Evaluate the cost-effectiveness of HYPE relative to BAU
  - Focus on incremental (relative to BAU) costs and effects
- Timeline
  - 2 cohorts: 2018-19 and 2019-20 school years (multi-year program)
  - 12-week intervention (focusing on short-term/immediate post-intervention outcomes)
- Audience
  - Primary: Federal funding agency (client) which aims to broadly inform the field
  - Secondary: Local school district
- Societal perspective

Ingredient List: HYPE Year 1

Category	Ingredient	Activity	Quantity	Quantity	Unit
Personnel	Coach - Trainer	Initial training by program developers	5C x 8H	40	Hour
Personnel	Coach - Trainer	Initial training of teachers	5C x 4H	20	Hour
Personnel	Coach - Trainer	Bi-weekly meeting with teachers	25T x 1H x 6W	150	Hour
Personnel	Coach - Trainer	Paperwork/Planning	25T x 1H x 6W	150	Hour
Personnel	Teacher - K-5	Initial training by coaches	25T x 4H	100	Hour
Personnel	Teacher - K-5	Weekly student intervention	25S x 1H x 12W	300	Hour
Personnel	Teacher - K-5	Bi-weekly coach meeting	25T x 1H x 6W	150	Hour
Personnel	Teacher - K-5	Paperwork/Planning	25S x .5H x 12W	150	Hour
Personnel	Teacher - K-5	Bi-weekly parent-teacher meeting	25P x .5H x 6W	75	Hour
Personnel	Parent Volunteer	Bi-weekly parent-teacher meeting	25P x 1H x 6W	150	Hour
Facilities	Classroom - Regular	Training of coaches	8H/1440H	0.6%	% Use
Facilities	Classroom - Regular	Training of teachers	(5C x 4H)/1440H	1.4%	% Use
Facilities	Classroom - Small	Weekly student intervention	(25S x 1H x 12W)/1440H	20.8%	% Use
Facilities	Classroom - Small	Bi-weekly coach meeting	(25T x 1H x 6W)/1440H	10.4%	% Use
Facilities	Classroom - Small	Bi-weekly parent-teacher meeting	(25P x 1H x 6W)/1440H	10.4%	% Use
Materials	Tablet	Weekly student intervention	(25S x 1H x 12W)/1440H	20.8%	% Use
Materials	HYPE App	Weekly student intervention	25S/5	5	Per item
Materials	HYPE Training Manual	Training materials	5C + 25T	30	Per item
Materials	HYPE Reading Workbook	Weekly student intervention	25S	25	Per item
Other inputs	Parent Transportation	Transportation	25P x 6M x 6W	900	Miles

*Collect ingredient data via surveys, logs, interviews, observation, etc.

Ingredient List: HYPE Year 2

Category	Ingredient	Activity	Quantity	Quantity	Unit
Personnel	Coach – Trainer	Bi-weekly meeting with teachers	25T x 1H x 6W	150	Hour
Personnel	Coach - Trainer	Paperwork/Planning	25T x 1H x 6W	150	Hour
Personnel	Teacher - K-5	Weekly student intervention	25S x 1H x 12W	300	Hour
Personnel	Teacher - K-5	Bi-weekly coach meeting	25T x 1H x 6W	150	Hour
Personnel	Teacher - K-5	Paperwork/Planning	25S x .5H x 12W	150	Hour
Personnel	Teacher - K-5	Bi-weekly parent-teacher meeting	25P x .5H x 6W	75	Hour
Personnel	Parent	Bi-weekly parent-teacher meeting	25P x 1H x 6W	150	Hour
Facilities	Classroom – Small	Weekly student intervention	(25S x 1H x 12W)/1440H	20.8%	% Use
Facilities	Classroom – Small	Bi-weekly coach meeting	(25T x 1H x 6W)/1440H	10.4%	% Use
Facilities	Classroom - Small	Bi-weekly parent-teacher meeting	(25P x 1H x 6W)/1440H	10.4%	% Use
Materials	Tablet	Weekly student intervention	(25S x 1H x 12W)/1440H	20.8%	% Use
Materials	HYPE App	Weekly student intervention	25S/5	5	Per item
Materials	HYPE Reading Workbook	Weekly student intervention	25S	25	Per item
Other inputs	Parent transportation	Transportation	25P x 6M x 6W	900	Miles

Price Ingredients and Calculate Costs

- Created project in *CostOut* (https://www.cbcsecosttoolkit.org/)
- Priced ingredients
  - Searched *CostOut* Database + entered my own prices into "MyPrices Database"
  - Prices are automatically adjusted (can change defaults if desired)
- Estimated costs based on national and local prices

References

- Bowden, A.B., Shand, R., Belfield, C.R., Wang, A., & Levin, H.M. (2017). Evaluating educational interventions that induce service receipt: A case study application of City Connects. American Journal of Evaluation, 38, 405-419.
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Questions

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