Archives of Scientific Psychology Reporting Questionnaire for Manuscripts Describing Primary Data Collections

JARS: ALL: These questions should be answered for *all* submitted manuscripts

MANUSCRIPT SECTION	Description
TITLE	Does the Title identify the variables and theoretical issues under investigation, as well as the relationship between them? Yes ☐ No ■ If no, please explain: There were two experiments involving different levels of participants and different measure tools in the manuscript, so we use succinct title based on their common traits.
AUTHOR NOTE For a review of what should be included in the Author Note, see the *Publication Manual of the American Psychological Association*: http://www.apastyle.org/manual/	Does the Author Note contain acknowledgment of special circumstances, for example: • use of data also appearing in previous publications, dissertations, conference papers? Yes☐ No■ If yes, please explain:

	• sources of funding or other support? Yes ☐ No■ If yes, please explain: • relationships that may be perceived as conflicts of interest? Yes☐ No ■ If yes, please explain:

SCIENTIFIC ABSTRACT	Does the Scientific Abstract describe:
Two experiments investigated the effect of level and location of guidance when learning physics. Experiment 1 demonstrated the overall advantage of an example-problem sequence over the reverse sequence and indicated that presenting instances of principle application in worked examples could facilitate physics learning for less knowledgeable learners. For the problem-example sequence, the results favored presenting the principle instances prior to the worked example rather than embedding them in the example. Experiment 2 investigated less knowledgeable learners' performance on immediate and delayed tests. The results demonstrated that principle guidance in the problem-solving phase of the problem-example sequence could reduce cognitive load relative to the equivalent condition without such guidance during the learning phase. However, this reduction of load did not translate to an advantage on other learning indicators in the problem-example sequence compared to the reverse sequence. The results largely contradict the expectations based on the productive failure and invention learning approaches and are more in line with the predictions based on a traditional cognitive load theory framework. We emphasize the importance of using experimental designs that alter one variable at a time to allow a determination of causality.	• the problem under investigation? Yes ■ No ☐ If no, please explain: • participants or subjects, specifying pertinent characteristics; in animal research, including genus and species? Yes ■ No ☐ If no, please explain:

	• study method, including: o sample size? Yes ■ No ☐ o any apparatus used? Yes ☐ No ■ o measures? Yes ■ No ☐ o data-gathering procedures? Yes ■ No ☐ o research design (e.g., experiment, observational study)? Yes ■ No ☐ If answered "no" for any of the study methods above, please explain: We used paper-based materials as experimental tools • findings, including effect sizes and confidence intervals and/or statistical significance levels? Yes ■ No ☐

	If no, please explain: • conclusions and the implications or applications? Yes ■ No ☐ If no, please explain:

INTRODUCTION	Does the Introduction:
For the Introduction please indicate whether the requested information can be found in this section of the manuscript, in a supplemental file, or whether the information is not relevant to the study. If the information is not relevant, please provide a brief explanation. **Worked Example-Based Learning** Worked examples provide information about all solution moves for a problem from the initial step to the final answer. They represent one of the most effective instructional strategies used to enhance learning. The worked example effect occurs when learning from instructions that explicitly provide solution procedures through worked examples is more effective and efficient than having learners induce these solution procedures from unguided attempts to solve the equivalent problems (Cooper & Sweller, 1987; Sweller, Ayres & Kalyuga, 2011; Sweller & Cooper, 1985; Van Gog, Kester & Paas, 2011). The effect is particularly strong for initial cognitive skill acquisition by novice learners. With information from a worked example, novices do not need to employ inefficient strategies for learning such as means-ends	• describe the importance of the problem? In manuscript ■ In supplemental files ☐ Not relevant ☐ If not relevant, please explain: • describe theoretical or practical implications of the problem? In manuscript ■ In supplemental files ☐ Not relevant ☐ If not relevant, please explain:

- review relevant scholarship in relation to previous work?

  In manuscript ■ In supplemental files ☐ Not relevant ☐

  If not relevant, please explain:

- review if other aspects of this study have been reported upon previously and how the current report differs from these earlier reports?

  In manuscript ■ In supplemental files ☐ Not relevant ☐

  If not relevant, please explain:

- describe the specific hypotheses or objectives, such as
  - theories or other means to derive hypotheses, if hypotheses were offered?

  In manuscript ■ In supplemental files ☐ Not relevant ☐

  If not relevant, please explain:

  - primary hypotheses?

  In manuscript ■ In supplemental files ☐ Not relevant ☐

  If not relevant, please explain:

	○ secondary hypotheses? In manuscript ■ In supplemental files ☐ Not relevant ☐ If not relevant, please explain: ○ planned exploratory analyses? In manuscript ■ In supplemental files ☐ Not relevant ☐ If not relevant, please explain:

	• describe how hypotheses and research design relate to one another? In manuscript ■ In supplemental files ☐ Not relevant ☐ If not relevant, please explain:

METHOD

Experiment 1

Participant or subject characteristics:

Experiment 1
The Year 10 students (age M = 16.00 years, SD = .41; 61 males and 64 females), and the Year 11 and 12 participants (age M = 17.23 years, SD = .66; 91 males and 44 females).

Experiment 2
Year 10 students (age M = 16 .00 years, SD = 0.45; 66 males and 63 females) studying at the same school in Taiwan.

Sampling procedures:

Obtained the participation agreements from the school principal, the class tutors and the students.

For the Method section, please provide the information requested below, regardless of whether it also appears in the rest of the manuscript or in supplemental files.

- What were the eligibility and exclusion criteria for participants or subjects, including any restrictions based on demographic characteristics?

The eligibility of participants was based on whether the participants had learned the targeted learning concepts in the experiments before participating in the experiments.

- What were the major demographic characteristics of participants or subjects as well as important topic-specific characteristics, or, in the case of animal research, the genus and species?

The participants were the Year 10 students coming from three normal classes while the Year 11 and 12 participants came from four special classes with advanced students in science and mathematics as established by a series of evaluating entrance examinations including a nationwide test in experiment 1. In experiment 2, Year 10 students came from four normal classes at a same Taiwanese high school. The main topic in both experiments was physics learning.

- What procedures were used for selecting participants, including
  - the sampling method

As described above.

  - the percentage of sample approached that participated

100 %

  - any self-selection, either by individuals or by nomination from others?

N/A

- What were the settings and locations where data were collected?

A Taiwanese high school locating in the mid-west area of Taiwan

- Were any agreements and payments made to participants?

No payments since the participants voluntarily agreed to participate in the experiements.

- Were IRB agreements obtained, ethical standards met, and safety monitored?
  Yes ■ No ☐

If no, please explain:

Sample size, power and precision:

Experiment 1
125 Year 10 students and 71 Year 11 and 64 Year 12 students at a high school in Taiwan.

Experiment 2
129 Year 10 students at a same high school.

- What was the intended sample size?
  n = 260 for Exp 1, 129 for Exp 2
- What was the actual sample size?
  n= 260 for Exp 1, 129 for Exp 2
- How was sample size determined:
  - power analysis?
    Yes ☐ No ■
  - other methods used to determine accuracy of parameter estimates?
    Yes ☐ No ■

  If yes, describe:

  - stopping rules or interim analyses?
    Yes ☐ No ■

  If yes, describe:

Measures and covariates:

Experiment 1
1.Principle test that comprised
2.Posttest
3.Subjective ratings of mental effort (a nine-point rating scale)

Experiment 2
1.Immediate test
2.Delayed test
3.Subjective ratings of mental effort (a nine-point rating scale)

- Please provide the definitions of all primary and secondary measures and covariates taken in the study, including measures collected but not included in this report

Measure name:	Definition:
1.Principle test/postest/immediate/delayed test 2. Subjective ratings of mental effort	1.Learning outcomes/achievements tests 2.Investigate the mental effort invested by the participants in each learning section

- What methods were used to collect data?

Paper-based testing materials.

- Were methods used to enhance the quality of measurements?
  - training and reliability of data collectors?
    Yes ■ No ☐
  - use of multiple observations?
    Yes ■ No ☐
- What are the known psychometric and biometric properties of instruments used in the study?

Measure Name:	Property:	Result:

Research design:

- Were conditions manipulated ■ or naturalistic □?

If manipulated, please complete **JARS:EXP** *(see below)*

If manipulated, were subjects randomly assigned to conditions?
Yes ■ No □

If randomly assigned, please complete **JARS: RCT** *(see below)*

If not randomly assigned, please complete **JARS:QED** *(see below)*

Miscellaneous:

- Are there any other aspects of the study's methods that are important for the interpretation or replication of its findings?

N/A

RESULTS

For the Results section, please provide the information requested in the questionnaire or provide the page number, table, or supplemental file in which the information can be found.

If your manuscript is accepted for publication, you will need to deposit your data set in an approved data repository. Please see Instructions to Authors for more information:
www.apa.org/pubs/journals/arc

Participant flow:

- How did participants move through each stage of the study and how many were lost at each stage, if any (use flow chart, if appropriate—*see Figure 1 below for an example*)?

N/A

Recruitment:

- Please provide the dates defining the periods of recruitment and repeated measures or follow-up.

Period Recruitment:	Start Date:	End Date:
N/A		

Missing data:

- Did you experience problems concerning statistical assumptions and/or data distributions that could affect the validity of findings?

Yes □ No ■

If yes, please describe:

	• Missing data
	  • Is missing data a cause of concern in this data set?
	  Yes☐ No■
	  • If missing data *was* a cause of concern, is there empirical evidence and/or theoretical arguments for the causes of data that are missing (e.g., missing completely at random (MCAR), missing at random (MAR), or missing not at random (MNAR))?
	N/A
	  • If missing data *was* a cause of concern, is there empirical evidence and/or theoretical arguments for the causes of data that are missing (for example, missing completely at random (MCAR), missing at random (MAR), or missing not at random (MNAR))?
	N/A

	• If missing data *was* a cause of concern, what methods, if any, were used for addressing missing data? N/A
DISCUSSION --- ***Statistics and data analysis:***	***For the Discussion section, please indicate whether the requested information can be found in this section of the manuscript, in a supplemental file, or whether the information is not relevant to the study. If not relevant, please provide a brief explanation.*** • Did you experience problems concerning statistical assumptions and/or data distributions that could affect the validity of findings? Yes☐ No■ If yes, please describe: • For inferential statistics (NHST), please indicate the a priori Type 1 error rate adopted: p<.10

- For each NHST conducted, regardless of whether significant results were obtained and regardless of whether or not reported in the text, please provide a log of the centrality (primary, secondary exploratory) of the analyses to the study's purpose, the analytic technique used, the direction, magnitude, degrees of freedom, and exact p-level associated with each test:

- For multivariable analytic systems (e.g., multivariate analyses of variance, regression analyses, structural equation modeling analyses, and hierarchical linear modeling)
  - provide the associated variance-covariance (or correlation) matrix or matrices:

N/A

  - describe any estimation problems (e.g., failure to converge, bad solution spaces), anomalous data points:
  - identify the statistical software program, if specialized procedures were used:

SPSS

- Is there a statement of support or nonsupport for all original hypotheses distinguished by primary and secondary hypotheses?

In manuscript ■ In supplemental files ☐ Not relevant ☐

If not relevant, please explain:

- Are post hoc explanations proposed?

In manuscript ■ In supplemental files ☐ Not relevant ☐

If not relevant, please explain:

- Are the similarities and differences between these results and the work of others discussed?

In manuscript ■ In supplemental files ☐ Not relevant ☐

If not relevant, please explain:

- Are results interpreted taking into account
  - sources of potential bias and other threats to internal validity?

In manuscript ■ In supplemental files ☐ Not relevant ☐

If not relevant, please explain:

  - imprecision of measures?

In manuscript ■ In supplemental files ☐ Not relevant ☐

If not relevant, please explain:

  - the overall number of tests or overlap among tests?

In manuscript ■ In supplemental files ☐ Not relevant ☐

If not relevant, please explain:

  - other limitations or weaknesses of the study?

In manuscript ■ In supplemental files ☐ Not relevant ☐

If not relevant, please explain:

- Is the generalizability (external validity) of the findings taken into account with regard to
  - the target population?

In manuscript ■ In supplemental files ☐ Not relevant ☐

If not relevant, please explain:

  - other contextual issues?

In manuscript ■ In supplemental files ☐ Not relevant ☐

If not relevant, please explain:

- Is there discussion of implications for future research, program, or policy

  In manuscript ■ In supplemental files ☐ Not relevant ☐

If not relevant, please explain:

JARS: EXP: These questions should be answered for all studies with an experimental manipulation or intervention (in addition to the JARS: ALL Questionnaire)

METHODS *Experimental manipulations or interventions:*	**In the Method section of a study with an experimental manipulation or intervention, please provide the information requested below, regardless of whether it also appears in the manuscript or a supplemental file. If the information requested is irrelevant to the study, briefly explain why.** • Please provide the details about the experimental manipulations or interventions intended for each study condition, including control groups and specifically including • the **content of the specific experimental manipulations or interventions**—a summary or paraphrasing of instructions (unless they are unusual or compose the manipulation, in which case they may be presented verbatim): 1. Introduction and instruction. 2. Grouping and learning. 3. post-testing. • the **method of manipulation or intervention delivery**—a description of apparatus and materials used and their function in the experiment: The participants were assigned to the experimental and control groups and used the paper-based reading materials. *Identify specialized equipment by model and supplier:* N/A • the **deliverers**, that is, who delivered the manipulations or interventions o level of professional training: Master degree in physics teaching

- level of training in specific manipulations or interventions:

higher

- the number of deliverers and, in the case of interventions, the M, SD, and range of number of individuals/units treated by each:

1

- the **setting**, that is, where the manipulations or interventions occurred:

in a normal physics class

- the **exposure quantity and duration**, that is, how many sessions, episodes, or events were intended to be delivered and how long they were intended to last:

three stages in per experiment

- the **time span**, that is, how long it took to deliver the intervention or manipulation to each unit:

about 6 hours

- activities to increase compliance or adherence (e.g. **incentives**):

N/A

- the **use of languages** other than English and the translation method:

Mandarin (Traditional Chinese)

Masking:

- Were participants, those administering the interventions, and those assessing the outcomes unaware of condition assignments?
  Yes☐ No ■

If no, why not?

The experiment conductor is one of researchers.

- If masking took place, how was it accomplished, and how was its success evaluated?

Units of delivery and analysis:

- Unit of delivery: How were participants grouped during delivery?

Randomly assigned by the sequence of participants' students ID number.

  - What was the smallest unit that was analyzed (and, in the case of experiments, that was randomly assigned to conditions) to assess manipulation or intervention effects (e.g., individuals, work groups, classes)?

groups consisting of students

- If the unit of analysis differed from the unit of delivery, please describe the analytical method used to account for this (e.g., adjusting the standard error estimates by the design effect or using multilevel analysis):

N/A

RESULTS

For the Results section, please indicate below the page number, table, or supplemental file in which the information can be found.

Participant flow:

- What was the total number of groups (if the experimental manipulation or intervention was administered at the group level), and what was the number of participants assigned to each group?

Please see the manuscript page 48 and 49

Treatment fidelity:

- What evidence is there that the deliverers of treatment adhered to the respective intervention manuals/guidelines?

See the manuscript page 16~17 and 34~35

- What evidence is there that the treatments were delivered competently?

See the manuscript page 16~17 and 34~35

Statistics and data analysis:	• Were the analyses intent-to-treat■, complier average causal effect□, or other or multiple ways□? Please explain: The studies aimed to compare the effects of different instructional sequences on physics learning, so the initial assigned treatment was done.
Adverse events and side effects:	• Please describe all important adverse events or side effects in each experimental or intervention: N/A

DISCUSSION	***For the Discussion section, please indicate below the page number, table, or supplemental file in which the information can be found.*** • Do results discussed take into account the mechanism by which the manipulation or intervention was intended to work (causal pathways) or alternative mechanisms? Yes■ No□ If no, please explain: • If an intervention is involved, is there discussion of the success of and barriers to implementing the intervention, and the fidelity of implementation? • Yes■ No□ If no, please explain: • Is there a discussion of the generalizability (external validity) of the findings taking into account o the characteristics of the intervention? o Yes■ No□

If no, please explain:

- how and what outcomes were measured?

  Yes■ No☐

  If no, please explain:

- length of follow-up?

  Yes■ No☐

  If no, please explain:

- incentives?

  Yes■ No☐

  If no, please explain:

- compliance rates?

  Yes■ No☐

  If no, please explain:

- Is there discussion of the **clinical or practical significance** of outcomes and the basis for these interpretations?

  Yes■ No☐

  If no, please explain:

JARS: RCT: These questions should be answered for all studies with an experimental manipulation or intervention that employed random assignment to experimental conditions (in addition to JAR:ALL and JARS: EXP)

METHOD	***In the Method section of a study that employed random assignment to experimental conditions, please provide the information requested below, regardless of whether it also appears in the manuscript or a supplemental file. If the information requested is irrelevant to the study, briefly explain why.***
Random assignment – method:	• What procedures were used to generate the random assignment sequence (including details of any restrictions—e.g., blocking, stratification)? the participants were randomly assigned to the groups by their student ID number.
Random assignment – concealment:	• Was the sequence concealed until experimental or intervention sequence was assigned? Yes ■ No☐ If no, why not?

Random assignment – implementation:	• Who generated the assignment sequence? one of researchers • Who enrolled participants? the class tutors • Who assigned participants to groups? one of researchers