Assessment Rubric for the Design of an Observational Experiment (1/2)

Scientific Ability		0	1	2	3
		Missing	Inadequate	Needs Improvement	Adequate
1	Is able to identify the phenomenon to be investigated	No mention is made of the phenomenon to be investigated.	An attempt is made to identify the phenomenon to be investigated but is described in a confusing manner.	The phenomenon to be investi-gated is described but there are minor omissions or vague details.	The phenomenon to be investigated is clearly stated.
2	Is able to find relevant theory and previously published theoretical and experimental data and to use them to explain the expected outcomes of the experiment	No theory or previously published data is included	Theory and previously published data are irrelevant or contain conceptual or mathematical errors	Theory and previously published data are relevant and well written with equations and some discussions but are not used to explain the expected outcomes of the experiment.	Theory is well written with equations and discussion relevant to the experiment. Published data are included and correctly used to explain the expected outcomes of the experiment.
3	Is able to decide what is to be measured and identify independent and dependent variables	The chosen measurements will not produce data that can be used to achieve the goals of the experiment.	The chosen measurements will produce data that can be used at best to partially achieve the goals of the experiment.	The chosen measurements will produce data that can be used to achieve the goals of the experi-ment. However, independent and dependent variables are not clearly distinguished.	The chosen measurements will produce data that can be used to achieve the goals of the experiment. Independent and dependent variables are clearly distinguished.
4	Is able to identify appropriate available sensors, instrumentation and/or software tools to measure physical quantities	Failure to identify appropriate tools and instrumentation or some of the chosen measurements cannot be made with the available equipment.	The list of appropriate tools and instrumentation is incomplete, the selection is not justified, or no details are given about how they will be used (range and appropriate number of data points to capture the phenomenon)	A complete list of appropriate tools and instrumentation is present with incomplete justification or with vague or incomplete details about how they will be used (range and appropriate number of data points to capture the phenomenon).	A complete list of appropriate tools and instrumentation is present with complete justification. All details about how tools and instruments will be used are provided and clear (range and number of data points are optimized to capture full response of system
5	Is able to design a reliable experiment that investigates the phenomenon	The experiment does not investigate the phenomenon.	The experiment involves the phenomenon but due to the nature of the design it is likely the data will not contain any interesting patterns.	The experiment investigates the phenomenon and it is likely the data will contain interesting patterns, but due to the nature of the design some features of the patterns will not be observable.	The experiment investigates the phenomenon and there is a high likelihood the data will contain interesting patterns. All features of the patterns have a high likelihood of being observable.
6	Is able to deal responsibly with safety and environmental issues related to experimentation as a technological process.	No mention is made to safety or environmental issues related to the designed experiment	Measures to deal with safety and environmental hazards are vague, incomplete, or insufficient	Measures to deal responsibly either with safety issues or with environmental hazards are presented	Measures to deal responsibly with both safety issues and environmental hazards are presented
	Is able to identify sources of experimental uncertainty	No attempt is made to identify experimental uncertainties.	An attempt is made to identify experimental uncertainties, but most are missing, described vaguely, or incorrect.	Most experimental uncertainties are correctly identified.	All experimental uncertainties are correctly identified.
7	Is able to evaluate specifically how experimental uncertainties may affect the data	No attempt is made to evaluate experimental uncertainties.	An attempt is made to evaluate experimental uncertainties, but most are missing, described vaguely, or incorrect.	Most experimental uncertainties are evaluated correctly, though a few contain minor errors, inconsistencies, or omissions.	All experimental uncertainties are correctly evaluated.
8	Is able to minimize experimental uncertainty	No attempt is made to minimize experimental uncertainty.	An attempt is made to minimize experimental uncertainty, but most major sources of uncertainty are not addressed or are addressed inappropriately.	Effective steps are taken to minimize most major sources of uncertainty, but one major source is not addressed.	Effective steps are taken to minimize all major sources of experimental uncertainty.
9	Is able to describe what is observed without trying to explain, both in words and by means of a picture of the experimental set-up.	No description is mentioned.	A description is mentioned but it is incomplete. No picture is present. Or, most of the observations are mentioned in the context of prior knowledge.	A description exists, but it is mixed up with explanations or other elements of the experiment. A labeled picture is present. Or some observations are mentioned in the context of prior knowledge.	Clearly describes what happens in the experiments both verbally and by means of a labeled picture.

Assessment Rubric for the Design of an Observational Experiment (2/2)

Scientific Ability		0 Missing	1 Inadequate	2 Needs Improvement	3 Adequate
10	Is able to construct a mathematical (if applicable) relationship that represents a trend in data	No attempt is made to construct a relationship that represents a trend in the data.	An attempt is made, but the relationship does not represent the trend.	The relationship represents the trend but no analysis of how well it agrees with the data is included (if applicable), or some features of the relationship are missing.	The relationship represents the trend accurately and completely and an analysis of how well it agrees with the data is included (if applicable).
11	Is able to devise an explanation for an observed relationship	No attempt is made to explain the observed relationship.	An explanation is made but it is vague, not testable, or contradicts the observations.	An explanation is made and is based on simplifying the pheno-menon but uses flawed reasoning.	A reasonable explanation is made and is based on simplifying the phenomenon.
12	Is able to identify the shortcomings in an experimental design and suggest specific improvements	No attempt is made to identify any shortcomings of the experimental design.	An attempt is made to identify shortcomings, but they are described vaguely and no specific suggestions for	Some shortcomings are identified and some improvements are suggested, but not all aspects of the design are considered.	All major shortcomings of the experiment are identified and specific suggestions for improvement are made.
13	Is able to identify the assumptions made in using the mathematical procedure	No attempt is made to identify any assumptions.	An attempt is made to identify assumptions, but most are missing, described vaguely, or incorrect.	Most assumptions are correctly identified.	All assumptions are correctly identified.
14	Is able to determine specifically the way in which assumptions might affect the results	No attempt is made to determine the effects of assumptions.	An attempt is made to determine the effects of some assumptions, but most are missing, described vaguely, or incorrect.	The effects of most assumptions are determined correctly, though a few contain errors, inconsistencies, or omissions.	The effects of all assumptions are correctly determined.
15	Is able to communicate the details of an experimental procedure clearly and completely	Diagrams are missing and/or experimental procedure is missing or extremely vague.	Diagrams are present but unclear and/or experimental procedure is present but important details are missing.	Diagrams and/or experimental procedure are present but with minor omissions or vague details.	Diagrams and/or experimental procedure are clear and complete.
16	Is able to behave with highest ethical standards	No references are mentioned and the role of each team member is not explicitly stated	The list of references is incomplete or does not appear in a standard professional format but the role of each team member is explicitly stated.	A standard professional list of references is used to credit work from other sources but the role of each team member is not explicitly stated.	A standard professional list of references is used to credit work from other sources and the role of each team member is explicitly stated.
17	Is able to work effectively in teams	No team meeting minutes or team peer-to-peer assessment is attached	Team peer-to-peer assessment is presented. Team meeting minutes is missing or does not show assignments of roles, tasks, and responsibilities	Team peer-to-peer assessment is not presented. Team meeting minutes is presented and shows assignments of roles, tasks, and responsibilities	Team peer-to-peer assessment is presented. Team meeting minutes is presented and shows assignments of roles, tasks, and responsibilities
18	Is able to make and justify a reasonable conclusion	No attempt is made to state or justify a conclusion	A conclusion is stated, but its justification is either absent, missing major steps, or containing major mistakes	A conclusion is stated and justified, but it is inconsistent with the results of the student's analysis, or it is incomplete	A conclusion is stated and justified, and is consistent with the results of the student's analysis
19	Is able to communicate his work in concise way	No attempt is made to state or write an executive summary	An executive summary is stated, but it is either very long or very short.	The executive summary has a reasonable length and format but some elements are missing (background, problem definition, relevant theory, experimental approach, results, and conclusions)	The executive summary has a reasonable length and format and contains all of the following: background, problem definition, relevant theory, experimental approach, results, and conclusions)

Definition: an experiment that students perform to investigate a new phenomenon. Thus, they do not make predictions or have expectations about its outcome. They need to collect data, analyze them and find a pattern in the data. They then need to explain the reasons for the pattern (if applicable), and/or construct a qualitative or quantitative relationship.

Example: Design an experiment to determine if there is a relationship between pressure and temperature of an unknown gas when its volume is kept constant.