The Effects of Activity Sheet Format on Student Engagement in the PISEC Program

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Abstract

There are many factors that affect how students engage in the learning process, especially when it comes to informal science education. This study examines how one such factor, the format of activity sheets presented to students, affects student engagement in an informal physics educational environment. The study was performed over two semesters at the same Partnerships for Informal Science Education in the Community (PISEC) site, where in the first semester students were provided with more traditionally layed out activity sheets and in the second semester the activity sheets were designed to present students with more options for expressing their work. We found that changing the format of the activity sheets to the more open design prompted students not only to engage more but also to change how they were engaging, increasing the quantity of questions, results, explanations, and scientific vocabulary they wrote down on the activity sheets. We also found evidence that explicitly prompting students to perform an action on an activity sheet such as making a drawing drastically increased the likelihood of them performing that action. These results suggest that educators can increase student engagement with activities by providing explicit prompts for students to complete while leaving it up for the students to decide on how best to respond to the prompt.

Introduction

Informal physics education is a type of education that prioritizes the interests of the students outside of a traditional classroom or school structure. It differs from traditional education in that it does not have set expectations on what students are supposed to learn, nor does it include formal assessments of what students have learned. Instead, students are provided with the freedom to pursue their own interests with regards to the physics content, as well as the ability to choose how they wish to engage with the predesigned curricula [1-3]. This is important for students as they are able to obtain ownership over their learning experience, increasing the value they place in it [1]. Additionally, students are able to express themselves in their own unique ways and pursue the goal of learning however they best see fit. This is important because different students learn in different ways, so presenting them with different avenues to learn helps reinforce the material [2].

While the freedom inherent to informal physics education can aid students in their learning of physics, there are issues that could arise due to the freedom granted to the students. One such issue is a failure to get students to actively engage with the material. Since students are generally allowed to pursue whatever interests them and engage however they wish, the onus is on program designers to create lessons and materials that pique student interests and help them to engage.

Getting students to be interested in the science is only the first step, however. It isn't just important for students to interact with the science, but it is also important how they interact [4]. It is desirable for students to engage in authentic science practices in order for them to build up their identities as scientists. Such practices include reporting results of experiments, using scientific vocabulary to communicate, and asking questions that can be answered using the scientific method [4]. Educators must then consider how they are designing their curricula to assist students in this communication.

One such design choice that educators make is the layout of worksheets or activity sheets that students are given. While a completely blank sheet of paper, or even no paper at all, provides students with the most freedom to express themselves, the lack of guidance would probably result in students losing sight of the concepts we hope for them to learn. On the other end of the spectrum are hyper detailed worksheets with correct and incorrect ways of filling them out. Students have been shown to place value in freedom of expression [1], so it is our goal to find an effective medium between these two extremes. A benefit of this study is that it will provide insight into how students learn and interact with physics, a notoriously difficult and alienating subject of study, in an informal environment.

Context

PISEC is a program designed to provide underserved children (ages 10-14) with the opportunity to engage in science outside of a traditional educational format. The participants were 50% female, 70% underrepresented racial/ethnic groups (primarily Hispanic/Latine), and >70% eligible for free or reduced-price lunch. The program accomplishes its goals by recruiting university student volunteers to attend the sessions to work and build relationships with the younger students over the 10 week program. This allows the younger students participate in the inquiry based science activities in a playful, engaging, and welcoming environment [3].

During a typical session, students are able to choose their own adventure of sorts, first determining what "room" (topic of emphasis) they want to explore, then determining how far they want to explore that topic. *Figure 1* shows the general structure of the layout.

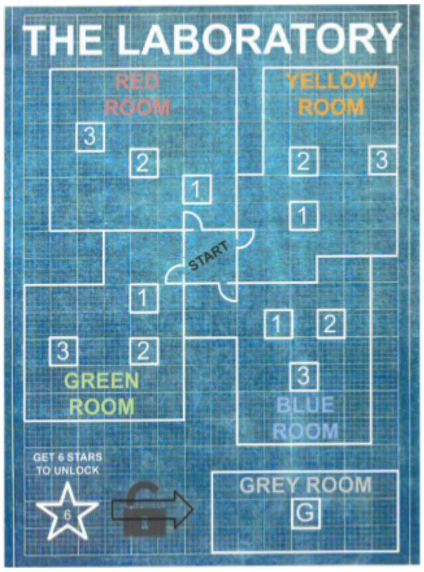

Figure 1: An abstract map of the PISEC site referred to as the game board. Each room color designates a general subject from the curricula for that semester (ex. blue corresponds to magnets in the Electricity and Magnetism curriculum). Students are free to go to any room color they prefer, but they must work through the levels in each room in order from 1 to 3. Students may leave a room at any time and go to a different room.

In each room, there are different levels of activities students can engage with, starting from exploratory activities which develop foundational understandings of a particular concept and ending with activities that expand on that concept and assist students in making connections between the concept of interest and things they might experience in the real world. An example of this progression would be starting at a level 1 activity where students are tasked with exploring how to complete circuits using different materials and ending at a level 3 activity where students are tasked with designing and constructing their own circuit using electronic components such as a breadboard.

For each level of each room that a student engages with, there is an activity sheet that they are given which offers a basic description of the activities and materials used at that level as shown in *Figure 2*. Each activity sheet also includes the prompts "What am I going to test", "What I found out during my test", "a new science word I learned", and "what it means". Additionally, the activity sheets from the fall semester of 2023 included the prompt "Drawing Space" with an empty space below it. On the back of each activity sheet was an empty space with the prompt "Additional space for notes and drawings".

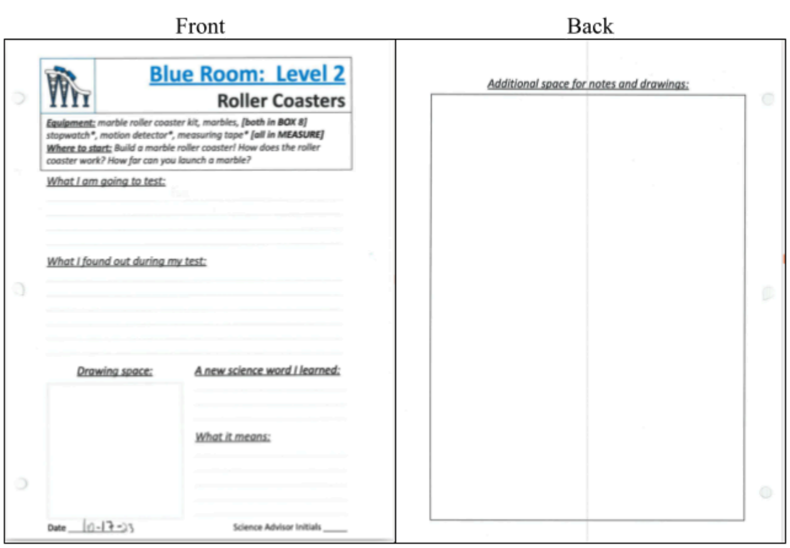

Figure 2: An example activity sheet from the FA23 semester. A title at the top describes the room color and level of the activity, as well as the general topic of the activity. Directly below this is a list of the equipment for the activity and some suggestions on how to begin interacting with them. Below that are a series of prompts with lined spaces where students can write their responses below each one. The backside of the activity sheet is left blank for students with the prompt "Additional space for notes and drawings"

There are no expectations for how students interacted with the different stations and materials given to them, although there are simple instructions or starting points on the activity sheets to help guide them. Instead, they are asked to do whatever they feel like and engage with whatever they find interest in. Each site has a site leader who does announcements, gets the program started, and floats around assisting the students and UE's (university volunteers). The UE's are usually assigned to a group of students (one per group), and they'd choose an activity to do together. A UE often works with the same group of students every week, but this is not always the case.

Research Questions

1. How does changing the format of the activity sheets in the PISEC program affect the quantity of engagement with the activity sheets amongst students?

2. How does changing the format of the activity sheets in the PISEC program affect the ways in which students engage with the activity sheets?

Methods

This study was conducted over two semesters of instruction at one PISEC site. The site was a Title 1 middle school in Boulder county which enrolls 5th-8th graders. 22 students attended the program regularly during the first semester in the fall of 2023 (FA23) which covered material related to classical mechanics. 18 students (13 of whom were returning) attended the program regularly during the second semester in the spring of 2024 (SP24) which covered material related to electricity and magnetism. The site leader was the same for both semesters of the study and was experienced in leading PISEC sites before the FA23. There were 5 UE's in the FA23 semester, three of whom were new to PISEC with the other two being returning participants. There were 7 UE's in the SP24 semester, four of whom were new, although one only participated sporadically throughout the semester, with the other three being returning participants. Of those three, one had participated in the same site in the FA23. The differences in the site leader and UE's should not have a significant impact on the data. However, it's possible that the ratio between the number of UE's and the number of students could have an impact on the engagement of the students. In FA23, there were 4.4 students for every UE, whereas in SP24, there were 2.6 students for every UE (3 if you don't include the UE who attended sporadically), a 41% (or 32%) decrease. This meant that each individual student was able to receive at least 30% more one on one assistance from UEs in the SP24 semester compared to the FA23 semester.

The main differences between the two semesters were the curricula that were presented to students and the format of the activity sheets provided to students participating in the PISEC program. In the FA23 semester, the activity sheets were lined where student responses were expected as shown in *figure 3*. In the SP24 semester, the lined spaces were instead replaced with empty boxes with dotted backgrounds, allowing for a more varied breadth of response types (e.g., writing or drawing) as shown in *figure 4* [4].

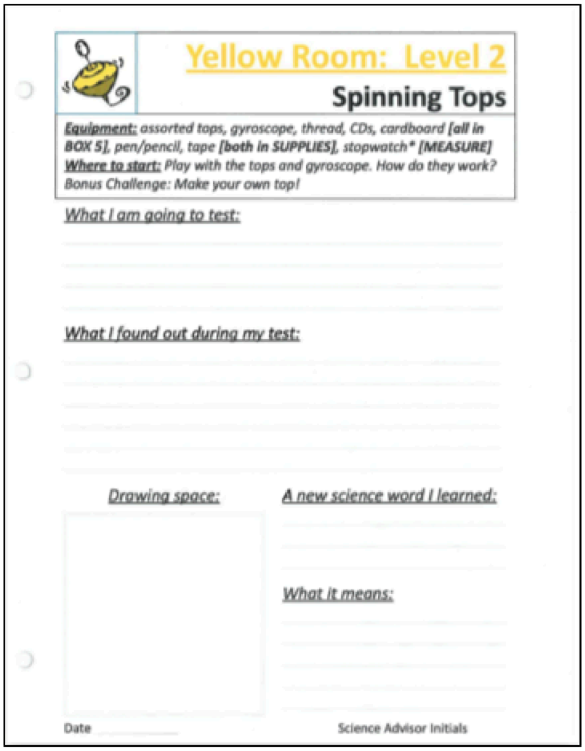
Yellow Room: Level 2
Spinning Tops
Equipment: assorted tops, gyroscope, thread, CDs, cardboard [all in BOX 5], pen/pencil, tape [both in SUPPLIES], stopwatch* [MEASURE]
Where to start: Play with the tops and gyroscope. How do they work?
Bonus Challenge: Make your own top!
What I am going to test:
What I found out during my test:
Drawing space:
A new science word I learned:
What it means:
Date
Science Advisor Initials

Figure 3 (Left): An empty activity sheet from the FA23 semester. It has lined spaces where students are expected to respond to prompts.

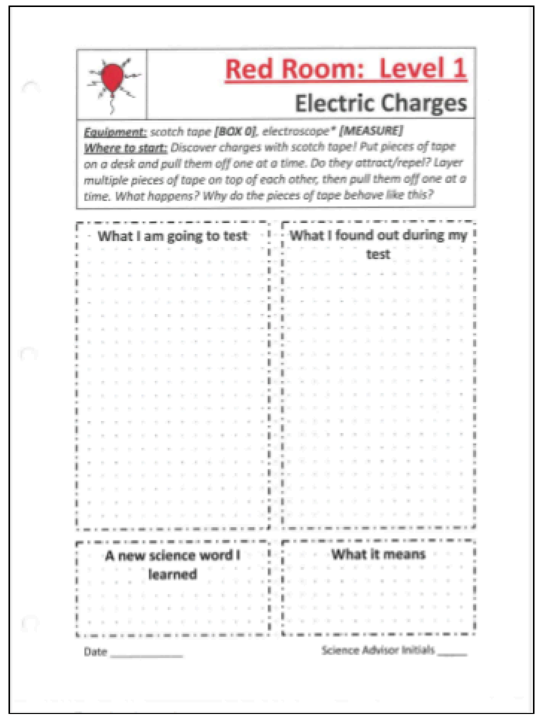
Red Room: Level 1
Electric Charges
Equipment: scotch tape [BOX 0], electroscope* [MEASURE]
Where to start: Discover charges with scotch tape! Put pieces of tape on a desk and pull them off one at a time. Do they attract/repel? Layer multiple pieces of tape on top of each other, then pull them off one at a time. What happens? Why do the pieces of tape behave like this?
What I am going to test
What I found out during my test
A new science word I learned
What it means
Date
Science Advisor Initials

Figure 4 (Right): An empty activity sheet from the SP24 semester. It has open boxes where students are expected to respond to prompts. The boxes have a dotted grid pattern to make it easier for students who wish to write to do so.

Another key difference between the activity sheets for the two semesters was that the FA23 activity sheets also included an explicit prompt for students to draw that was separate from the additional space provided for notes and drawings which was present in both semesters. This explicit drawing space was removed from the SP24 activity sheets, allowing for more space to respond to the other prompts as well as for all the prompts to be fit onto one page.

In order to determine the effects of changing the activity sheets, we conducted a qualitative coding analysis [5] on 207 (86 FA23, 121 SP24) activity sheets from 41 students (22 FA23, 18 SP24) using *a priori* codes. Many of these codes originated in an earlier related study performed by Cai Cash [4] and were refined after a first coding of the data.

Code	Cash's Definition	Tice's Definition
Question	Asks a question about the experiment	Asks a question about the experiment; writes a question that can be answered using the tools of science; does not need to have a question mark, but needs to be grammatically phrased as a question, e.g., "What are the differences in the masses" ("if the masses are different" would NOT be coded as question)
Response	Responds to a question that prompts beyond the main boundaries of the experiment, e.g. "What do you think is inside?" "oil"	Did not code for
Vocabulary	Uses a "science word", e.g. "electricity", "magnetism", "current", etc. in context or has definition of "new science word"	Reports a word "science word", e.g. "electricity", "magnetism", "current", etc in a sentence and/or defines it. Use of colloquial science words in simple, nonscientific sentences does not count ("I used fridge magnets", "the box weighed a lot", etc.). Equipment listed on the activity sheet does not count as vocab, unless they write it in science word box and define

Figure 5: Comparison of key differences between the codebook used by Cai Cash to perform their research and the codebook used by Benjamin Tice to perform his research. The full codebooks can be found in the Appendix at the end of this paper.

One main alteration made between Cash's original codebook and our new codebook were the explicit distinction made in the "Scientific Vocab" code between the use of colloquial scientific terminology and subject specific scientific terminology. Cash defined Scientific Vocab as, "*Uses a 'science word', e.g. 'electricity', 'magnetism', 'current', etc. in context or has definition of 'new science word'*," whereas we defined it as, "*Reports a word 'science word', e.g. 'electricity', 'magnetism', 'current', etc in a sentence and/or defines it. Use of colloquial science words in simple, nonscientific sentences does not count ('I used fridge magnets', 'the box weighed a lot', etc.). Equipment listed on the activity sheet does not count as vocab, unless they write it in science word box and define*". The reason this distinction was made was because we believed there to be a categorical difference in the use of such terms, as people use colloquial scientific terminology on a daily basis without participating in what we would consider to be scientific practices. An example of this might be one student writing "the car was speedy," which uses the colloquial term "speed", and another student writing "we measured how the speed of the car changed," which refers to the physics property of "speed". Another significant alteration was made to the "Question" code, where we specified that to qualify for this code, a segment of writing must be grammatically phrased as a question as opposed to simply including question words. This change was made to differentiate between the mindsets students were approaching problems with; were they answering a prompt or asking a question of their own. An example of this might be when students are responding to the prompt "What are you testing?", one might write "how the poppers bounce" (a response) and another might write "how do the poppers bounce" (a question).

After the alterations were made to the codebook, we checked it for agreement so as to establish inter-rater reliability. We did this by having two researchers (first author Tice and advisor Hoehn) independently code a subset of the data. Comparing the two sets of codes resulted in a Cohen's Kappa of 0.9716, with 100% agreement being achieved after discussion. It was during this discussion that the alterations to the "Question" code and the "Scientific Vocabulary" code were finalized.

In addition to the qualitative coding, we also performed a word count and a page count to gauge the quantity of student engagement. This also allowed us to normalize our data so that apt comparisons could be made between the two semesters without being skewed by the amount students were engaging with the activity sheets. The significance of the changes in code counts between semesters were tested using Fisher Exact tests with $\alpha = 0.05$.

Results

Quantity of Engagement As shown in table 1, in FA23 86 out of 170 pages contained writing or drawing and in SP24 121 out of 211 pages contained writing or drawing. There was no significant difference between the number of pages that students wrote on between the two semesters ($p = 0.21$). However, students in SP24 wrote considerably more words than in FA23, an increase of 22.3% more words per page, 110% more words per student, and an overall increase of 72.3% more words. This result supports the hypothesis that the open format of the box activity sheets encourages students to engage more than the lined format.

Semester	FA23	SP24
Total Written Pages	86	121
% Pages with Writing	50.59	57.35
Words per Page	21.5	26.3
Words per Student	84.0*	176.8*
Drawings per Page 1. Captions per Drawing 2. Equipment per Drawing 3. People per Drawing	0.63* 1. 0.17* 2. 0.87 3. 0.39	0.27* 1. 0.48* 2. 0.73 3. 0.18

Table 1: Quantity of Student Engagement with Activity Sheets. Each value is described by the corresponding label in the left side of the table.

*statistically significant differences between the two semesters at the alpha=0.05 level are indicated with an asterisk

Surprisingly, FA23 activity sheets had significantly more drawings than SP24 activity sheets ($p < 0.0001$) despite there being more space on the activity sheets for students to draw in SP24. We believe this result was because of the explicit prompting of students to create a drawing in the FA23 activity sheets which was lacking from the SP24 sheets. As seen in Table 1 SP24 drawings included significantly more captions than their FA23 counterparts ($p = 0.0029$), but other than that there was no significant difference between the drawings produced in either semester. The increase in use of captions could indicate an increased interest in using the drawings as an explicit communication tool, or it could simply be a result of the increased levels of writing prompted by the change in format.

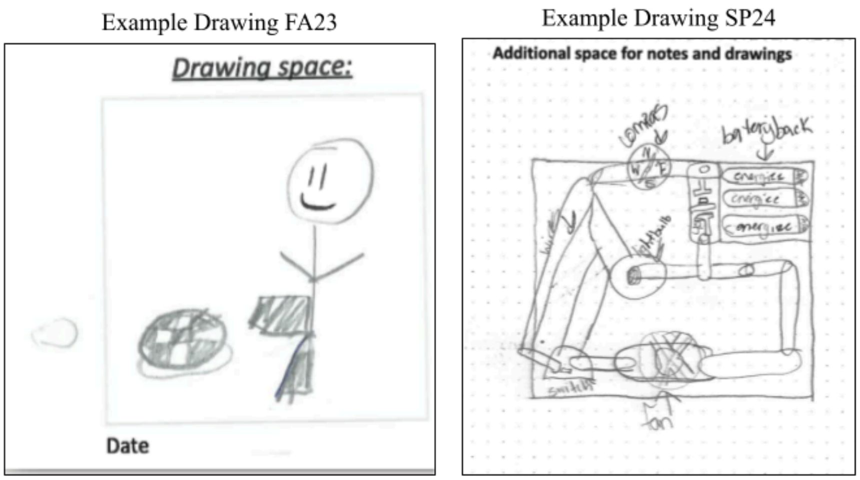

Figure 6: A comparison of two example drawings from activity sheets between two semesters. The drawing from the FA23 semester (left) depicts a student playing with an air puck, but includes no captions. The drawing from the SP24 semester (right) depicts a circuit a student built, including captions to make sense of the drawing.

Quality of Engagement While the results for the quantity of engagement were both surprising and interesting, the main focus of this study was on how the differing activity sheet formats affected the quality of student engagement. For the purposes of this study, quality is defined as the density of Scientific Practices including vocabulary usage within student engagement with a higher quality being defined as a higher density because the desired outcome of providing students with the activity sheets is for the students to engage scientifically with the activity described in the sheet.

Overall, the SP24 semester had significantly more Scientific Practices than the FA23 semester ($p = 0.0044$) as shown in Table 2. While the individual Scientific Practice codes were generally not significantly different, there was an increase across the board for each practice from FA23 to SP2

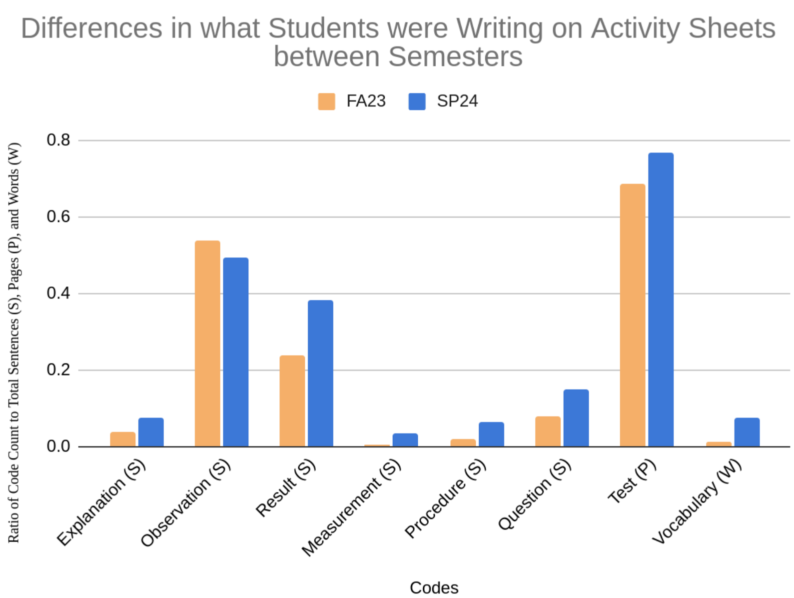

Figure 7: A chart representing the data from Table 2

Semester	FA23	SP24
Explanation per sentence	0.039	0.076
Observation per sentence	0.539	0.492
Result per sentence	0.237*	0.382*
Measurement per sentence	0.007	0.034
Procedure per sentence	0.020	0.065
Question per sentence	0.079*	0.149*
Test per page	0.686	0.769
Vocabulary per word	0.014*	0.076*

Table 2: Differences in what students were writing on activity sheets between semesters. Each value is a ratio of the total count of that code for a semester divided by either the total sentence count, total written page count, or total word count for that semester depending on which ratio was most relevant.

*statistically significant differences between the two semesters at the alpha=0.05 level are indicated with an asterisk

Notably, the Question code saw a significant increase from FA23 to SP24 ($p = 0.0434$), possibly demonstrating that students were more inquisitive when presented with the open box format. At the very least, it demonstrates that students were more inclined to write down their queries when compared to the lined format.

Another notable data point was the increase in Result codes from FA23 (23.7%) to SP24 (38.2%). This shows that students from the SP24 semester were 61.2% more likely to record a result when they wrote something down than students from FA23. In addition to the increase in Results, there was a 93.4% increase in Explanations from FA23 (3.95%) to SP24 (7.63%), and a 229% increase in Procedures, supporting the hypothesis that the change in format increased student engagement with scientific practices.

The impact of explicit prompting on student engagement that was observed in the data collected for the "Drawing" code is also supported by the data collected for the "Measurement" code. We observed an increase in this code from FA23 to SP24 (0.66% to 3.4%), which we believe to be practically different if not statistically significant ($p = 0.1001$). The vast majority of instances of this code in SP24 activity sheets occurred on the "What is a Magnet" activity sheet pictured below which contained a data table for students to fill out, implying that the increase was a direct result of the explicit prompting of students to take measurements.

The most apparent and most surprising difference was the increase in use of Scientific Vocabulary from FA23 to SP24 ($p << 0.001$). This was a 464% increase between semesters after accounting for the already notable increase in word count. We hypothesized that this marked increase might have occurred as a result of the change in curricula between the two semesters because of the stipulation in the Scientific Vocabulary code regarding colloquial uses of scientific terminology. We believed that the mechanics curricula might have been easier to describe using the colloquial vocabulary compared to the E&M curriculum which requires the accurate and scientific use of vocabulary to describe the observed phenomenon. To test this hypothesis, we checked the difference in Scientific Vocab between these two curricula at two different PISEC sites that did not change the activity sheet format. We found that there was only a 1% increase from the mechanics curriculum to the electricity and magnetism curriculum at the first control site and only a 17% increase at the second site. This suggests that the driving factor in the 464% increase between the FA23 and SP24 semesters was the change in activity sheet format.

Discussion

An unexpected but unsurprising takeaway from the above data is that explicitly prompting students to do something significantly increases the likelihood of them doing it. This supports the idea that being explicit with instruction is very important in education. A reason for this might be that without explicit instruction, students can confuse themselves when considering what actions to take, and it is quite likely that they choose to expend energy performing irrelevant tasks. Due to the format of PISEC, students are never forced to participate in an activity they are uninterested in, so if a student receives an activity sheet, that means they have already expressed some desire in exploring the relevant material. By utilizing more explicit prompts describing how students can effectively engage with the activities they're interested in, it is possible to aid students in their pursuit of attaining a deeper understanding of the content they are interested in. It should also be possible to include such prompts without limiting how students can choose to engage.

Another clear takeaway was that the change in activity sheet format significantly increased students' use of scientific vocabulary. A hypothesis we have for why this might have occurred is that students may have felt more creatively inclined and personally interested in the material as a result of the new format, allowing them to more deeply engage with the content. A reason we have for believing this might be the case is that students could interpret the lined activity sheet as more of an assignment that they need to complete, causing them to develop an antagonistic relationship with the work. On the other hand, the open box format center's the student by allowing them to express themselves however they wish, causing them to develop a collaborative relationship with the activity sheet. This hypothesis is also supported by the overall increase in scientific engagement from FA23 to SP24, as well as the paper by Fiedler et al. where they discuss how increasing the agency amongst students with regards to choosing how they engage increases the value students place in the work that they are completing [1].

A separate explanation for the increase in vocabulary between the semesters was that it was random chance. The sample size of the students was relatively small for each semester (approximately 20), so it is completely possible that the students in the second semester simply used more vocab than the students in the first semester, although this seems unlikely considering the results of checking the change in vocab usage between semesters at other sites. A final hypothesis for the increase in scientific vocab is the differences in the UEs between the two semesters. During SP24, the returning UEs were all physics majors (for a total of 3) whereas there was only one physics major who was a returning UE in FA23. It's possible that this intersection of experience in the PISEC program and area of focus for study resulted in the increased engagement with the underlying physics, which was then expressed through the increase in use of scientific vocabulary. Additionally, the difference in UE to student ratio between the two semesters could have allowed the UEs from SP24 to better assist the students in developing their scientific identities and skills. Overall, the increase in scientific vocabulary was surprising and further research must be conducted for any concrete conclusions to be drawn.

A final takeaway from the results of our research was that the change to an open box format from a lined format caused students to be more inquisitive, as well as being more focused on results. An explanation for this could be the hypothesis that the changes in the activity sheet format caused them to view the activities as more of an exploration of concepts and less of an assignment to complete. Again, it is impossible to infer from the data what exactly students were thinking and feeling, but it is interesting that this hypothesis is capable of explaining many of the discrepancies between the two semesters.

Conclusion and Future Work

Through a qualitative coding analysis of notebooks from the PISEC program at one site across two semesters, we found that overall levels of engagement amongst students increased when changing the format of the activity sheets from lined responses to open boxes. Additionally we found that the content of that work demonstrated an increase in engagement with scientific practices when moving from the lined activity sheets to the open format. It is unclear if these results are applicable outside of the PISEC program, but we at least recommend that future PISEC notebooks are created using the open box format instead of the lined format. Additionally, we recommend that if it is desired for students to engage in a specific way or for them to perform a specific action that the desired engagement or action is explicitly prompted.

Future work should look to confirm the results of this research, as well as expand its bounds to include more traditional learning environments. Additionally, it should attempt to gain an understanding of the differences in the thoughts and feelings of students when presented with lined activity sheets versus open box activity sheets in order to better make sense of the differences in outcomes that this difference creates, similar to the research performed by Fiedler et al. [1].

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[1] Fiedler, Brett L., et al. "A design-based informal physics program from a youth perspective." *2018 Physics Education Research Conference Proceedings*. 2018.

[2] Redish, E. "Teaching Physics with the Physics Suite, Chapter 2: Cognitive Principles and Guidelines for Instruction". John Wiley & Sons Inc. 2003.

[3] Wulf, R., Hinko, K., Finkelstein, N. "Promoting Children's Agency and Communication Skills in an Informal Science Program". AIP Conference Proceedings 1513, 430 (2013). January 23, 2013.

[4] Cash, C., Finkelstein N., Hoehn, J.R. "It's not just the writing: Designing science notebooks to engage youth in informal environments".PERC Proceedings 2024

[5] Yi, Erika. "Themes don't just emerge: Coding the qualitative data." *Medium data science* (2018).

Appendix

Cai Cash's Complete Codebook

Name	Description
Engagement	
Drawing	The excerpt includes a drawing or sketch.
Caption	The drawing includes writing that serves as a description of what is happening or otherwise corresponds to the drawing.
Doodle	Drawing includes a doodle or something unrelated to a science experiment (e.g. a smiley face, star, or heart)
Equipment	Drawing includes materials or equipment listed in the “Equipment” section of the activity sheet, either alone (e.g. a diagram of a circuit board) or involved in an experiment (e.g. people jumping rope with an extension cord)
People	The drawing depicts a person.
Response	Responds to a question that prompts beyond the main boundaries of the experiment, e.g. “What do you think is inside?” “oil”
Video	Communication took place on a computer/camera (and was not part of the notebook)
Personal	
Fun	Describes having fun or enjoyment of the process (e.g. “Wow!”)
Mission Control	Interacts with Mission Control (“Hi, how are you? or direct reference)
Personal Ownership	uses the term “I” or “my”, every instance is counted (e.g. "I saw my…" is 2 counts)
Scientific Practice	The text and/or drawing engages with some aspect of scientific practice (establishing procedure, recording results or observations, etc.)
Explanation	Offers an explanation for what is happening (or why something is happening)
Correct	The given explanation aligns to some extent with expert-level understanding of the scientific concepts (e.g. attract = bringing things together vs. repel = pushing things apart)
Incorrect	The given explanation (though creative!) does not align with expert-level understanding of the scientific concepts (e.g. “current [in the wire] comes from electricity on the ground”)
Indeterminate	The given explanation is difficult to confirm or is partially correct and partially incorrect (e.g. a drawing of a magnet with “north” and “south” labeled, or “The water makes the oil float”)
Observation	Documents an observation from the experiment, e.g. “I saw…” or “It was…”
Result	Documents the findings/results of an experiment or test

Name	Description
Measurement	Documents data-taking (in a data table or otherwise)
Prediction	Makes a prediction about something that will happen (e.g. “I think it will…”, “it should…”) — either explicit or implicit
Procedure	Any description of “this is what we did” or describing steps
Question	Asks a question about the experiment
Test	The student responds directly to the “what I am going to test” prompt (e.g. “I am going to test…”)
Unclear	The drawing or writing cannot be clearly distinguished.
Vocabulary	Uses a “science word”, e.g. “electricity”, “magnetism”, “current”, etc. in context or has definition of "new science word"
Definition	

Benjamin Tice's Complete Codebook

Name	Description
Engagement	
Drawing	The excerpt includes a drawing or sketch.
Caption	The drawing includes writing that serves as a description of what is happening or otherwise corresponds to the drawing.
Doodle	Drawing includes a doodle or something unrelated to a science experiment (e.g. a smiley face, star, or heart)
Equipment	Drawing includes materials or equipment listed in the “Equipment” section of the activity sheet, either alone (e.g. a diagram of a circuit board) or involved in an experiment (e.g. people jumping rope with an extension cord)
People	The drawing depicts a person. (Note: not coded if the people in the drawing are part of the equipment, e.g., parachute people / toys)
~~**Response**~~	~~**Responds to a question that prompts beyond the main boundaries of the experiment, e.g. “What do you think is inside?” “oil” - Did not code for**~~
Video	Communication took place on a computer/camera (and was not part of the notebook)
Personal	
Fun	**Describes having fun or enjoyment of the process (e.g. “Wow!”) - Did not occur**
Mission Control	**Interacts with Mission Control (“Hi, how are you? or direct reference) - Did not occur**

Name	Description
Personal Ownership	uses the term “I” or “my”
Scientific Practice	The text and/or drawing engages with some aspect of scientific practice (establishing procedure, recording results or observations, etc.)
Explanation	Offers an explanation for what is happening (or why something is happening)
Correct	The given explanation aligns to some extent with expert-level understanding of the scientific concepts (e.g. attract = bringing things together vs. repel = pushing things apart)
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Observation	Documents an observation from the experiment, e.g. “I saw…” or “It was…”
Result	Documents the findings/results of an experiment or test
Measurement	Documents data-taking (in a data table or otherwise)
Prediction	Makes a prediction about something that will happen (e.g. “I think it will…”, “it should…”) — either explicit or implicit
Procedure	Any description of “this is what we did” or describing steps
Question	Asks a question about the experiment; writes a question that can be answered using the tools of science; does not need to have a question mark, but needs to be grammatically phrased as a question, e.g., “What are the differences in the masses” (“if the masses are different" would NOT be coded as question)
Test	The student responds directly to the “what I am going to test” prompt (e.g. “I am going to test…”)
Unclear	**The drawing or writing cannot be clearly distinguished. - No examples found**
Vocabulary	Reports a word “science word”, e.g. “electricity”, “magnetism”, “current”, etc in a sentence and/or defines it. Use of colloquial science words in simple, nonscientific sentences does not count ("I used fridge magnets", "the box weighed a lot", etc.). Equipment listed on the activity sheet does not count as vocab, unless they write it in science word box and define
~~**Definition**~~	~~**Did not code for**~~