

# Some Random Observations

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DC06

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## The Tale Of A Whale

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Working alongside historian of science Robert Pennock at Michigan State University from 2000-2002 inspired an interest in the subject of evolution, and the arguments against it, such as the "whale out of nothing".

A common thread in many such arguments seemed to be a misunderstanding of what it means for a process to be random.

BUT...

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## The Big Question

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### ...what does it mean to be random?

Clearly, this is a "hidden" variable in any dealings with many aspects of modern science.

Everyone in the room might agree a process is random, yet no two people in the room agree on what "random" means!

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## A Little Answer

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While there seem to be different definitions for "random" in various fields, the key in physics would seem to be "an event for which you cannot always know the outcome."

- Unpredictable Results
- Uninfluenced Event
- Independent Trials

But what do students think?

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## Two Random Surveys

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Two online surveys were administered in Spring Semester 2004 via Kansas State University's anonymous survey system. Five groups participated in these surveys.

- Physical World (N=111)
- General Physics 2 (N=101)
- Descriptive Physics (N=146)
- Engineering Physics 2 (N=222)
- Faculty/Grad Students (N=22)

The first four groups were given extra credit for participating.

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## Survey One

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The first survey was two open-response items, 500 words maximum length:

1) What does "random" mean to you?

2) Is the result of rolling dice random? Why or why not?

Subjects were given one week to complete this survey. Keywords were attached to answers, then sorted into groups.

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## Survey One Keywords

1. **(Lack of) Bias:** Equal Outcomes, Unequal Outcomes.
2. **Lack of Connections:** Independent, No similarities, Unrelated.
3. **Colloquial Meanings:** Irrelevant, Spontaneous, Unexpected, Unlikely, Unusual, Out of Context.
4. **Lack of Information:** Unknown Odds, Unknown Options, No limits, Uncertain, Unclear, Unconstrained, Unpredictable
5. **Lack of Intent:** Arbitrary, Uninfluenced, Unplanned
6. **Lack of Pattern:** Disorder, No Pattern, Inconsistent, Small N needed.
7. **Other:** Synonyms, Uncategorizable

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## Survey One Results

### What does Random mean?

Lack of Bias	5%
Lack of Connections	6%
Colloquial	22%
Lack of Information	19%
Lack of Intent	18%
<b>Lack of Pattern</b>	<b>30%</b>

### Are Dice Random?

Lack of Bias	13%
Lack of Connection	3%
Colloquial	4%
<b>Lack of Information</b>	<b>52%</b>
Lack of Intent	17%
Lack of Pattern	11%

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## Survey One Results

- The "higher level" the group, the less likely they were to use colloquial definitions of randomness.
- Responses were otherwise very similar across subject groups.
- Almost all responses by those who thought dice were non-random (113/141 keywords) invoked the idea that too much was known about the possible results (i.e. range of options).

Responses overall suggested that patterns and information figured strongly in the understanding of randomness.

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## Survey Two

The second survey was multiple choice in design. Item 1 focused on how much information is too much for something to be random, as well as touching on the Bias issue.

Multiple choice online survey, multiple responses allowed.

In radioactive materials, radiation is emitted when the nucleus of an atom "decays", breaking down into two or more pieces. It is not possible to know for sure exactly when a given nucleus will decay.

Please check off any of the situations below that you believe would be **random**.

Situation: You observe a nucleus without doing anything to it, and there is...

- a 50% chance the nucleus will decay into two known pieces.
- a 10% chance the nucleus will decay into two known pieces.
- an unknown chance the nucleus will decay into two known pieces.
- a 50% chance the nucleus will decay into an unknown number and type of pieces.
- a 10% chance the nucleus will decay into an unknown number and type of pieces.
- an unknown chance that the nucleus will decay into an unknown number and type of pieces.

None of these situations is random (please do not check any other boxes).

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## Survey Two

Item 2 focused on the issue of patterns.

Multiple choice, one response allowed.

Which of the following statements do you most closely agree with?

- Random events can never, under any circumstances, result in patterns.
- Random events can result in patterns in some situations, but these patterns don't mean anything.
- Random events can result in meaningful patterns in some situations.
- Random events always result in meaningful patterns.

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## Survey Two Results

Item 1:

- The more information given, the less likely subjects thought it was random, in every group.
- 10% vs. 50% showed little difference.

Item 2:

- "meaningless patterns" generally most popular result.
- "Other" group favored "never", despite supposedly knowing about nuclear decay curves.
- Large number of "never" in every group, suggests more philosophical than physical stance.

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## Summary

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Students do seem to have generally correct ideas regarding randomness, but take things too far.

Student criteria for randomness do seem to be context-dependent.

It might be helpful to get students to use a "functionally random" concept that need not be linked to their philosophical views. "Close enough for Jazz," in other words.

For more information (so that this talk is no longer so random), contact me at [dvandom@phys.ksu.edu](mailto:dvandom@phys.ksu.edu).