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# NEWSPAPER PHYSICS: INSTRUCTION, ASSESSMENT, CONTENT, AND COMMUNITY

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**Newspaper Physics: Instruction, Assessment, Content, and Community**

**Synopsis**:

I will describe and illustrate a physics course for students whose only knowledge of physics is that they do not like it! The physics content is driven entirely by what appears in the daily newspapers and generally covers most physics topics in a semester. This course was structured as a "Learning Community" at Iowa State University combining English and Physics into a single course. Most of the writing assignments were about physics.

# Newspaper Physics:
# Instruction, Assessment, Content, and Community

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**Abstract**

We will describe and illustrate a physics course for students who have little interest in or knowledge of physics. The physics content is driven entirely by what appears in the daily newspapers and generally covers most physics topics in a semester. This course was structured as a "Learning Community" at Iowa State University combining English and physics into a single course. Most of the writing assignments were about physics.

We will outline techniques for high school teachers to bring real and timely information into the classroom on essentially all topics: literature, English, psychology, history, sociology, art, mathematics, physics, chemistry, and statistics. Good national and local newspapers contain a wealth of information that can be used for instruction. Students can feel and be connected to current and topical events, be confronted with conflicting points of information, and strive to think critically.

## 1 The Learning Community

This course was originally taught as part of an English-physics Learning Community course that was fully integrated between the physics and the English.[1] The physics content was driven by articles that appeared in the daily newspapers and the English content comprised writing rhetorical, argumentative, opinion, biographical, etc., pieces that were mainly centered around the physics discussions. The students kept a physics journal, wrote reflection pieces on the content of newspaper articles, interviewed physicists on campus and at Fermilab[1], analyzed these articles, and presented similar physics discussions on articles of their choosing.

The course was three credits for English and three credits for physics, satisfying both the language and natural sciences requirements of the College of Liberal Arts and Sciences, and was effectively a six credit course with one letter grade.

[1]The English instructor was Jennifer Lowery, English Department, Iowa State University. The rigor, structure, and *esprit de corps* of the course was entirely due to Dr. Lowery.

This 15-week course consisted of a weekly structure of two hour-long physics discussions and three English sections, so the students met five times per week. In a given semester, the class consisted of 20 mostly first-year students, about equally divided between male and female. During mid-semester the whole class takes a trip to Fermilab[1] where they individually interviewed physicists, engineers, and graduate students from around the world, and write these up as newspaper interviews.

There were no exams or any traditional assessment strategies used in this course. Instead, writing assignments were given once per week on a wide range of topics (biographical, rhetorical, opinion, etc.) and verbal and written feedback were given by the instructors. In addition, students engaged in self-criticism in small writing groups of four students each. These writing groups were very similar to professional writers' workshops. In the end, students were evaluated by the whole portfolio they had written during the semester. The community of students created a collage or class book in the end. Finally, at least once, we had a student driven spaghetti dinner.

## 2 Instructional modeling

Six steps of an instructional modeling of the course are

1. *Selecting newspaper articles* by both instructors and students. This essentially involves a careful but pleasurable reading of two or three newspapers during the day, and saving the likely ones so that, over a week's time, there are several articles to choose from.

2. *Analyzing* the articles for physics content and appropriateness for a classroom. The appropriateness is a judgment about pedagogical content, avoiding redundancy, and scientific or cultural interest. There are several varieties of acceptable newspaper articles, those that are

   *i.* about physics

   *ii.* about physicists (obituaries of Hans Bethe, etc.)

   *iii.* about art or music that involve physics

   *iv.* about forensics (auto accidents, art forgeries)

   *v.* about archeology (dating, satellite imaging)

   *vi.* about human folly

   *vii.* about public policy (nuclear weapons, tasers, earthquake prediction)

   *viii.* about random events (statistics)

   The popular and interesting ones generally come from *iii*, *iv*, *v*, and *vi*, although some obituaries are fascinating and topics like the use of Tasers are topical. Any discussion of statistics is usually an eye-opener for students.

3. *Extracting physics concepts* throughout an article. Sometimes the physics content is not large enough to support a one hour discussion. Good articles, such as the 'jeep' article in the next section, are easy to extract the physics concepts of gravitational potential energy, angular momentum and energy conservation, Newton's First Law, and probability.

4. *Constructing a science storyline* that combines the facts as presented in the article that are consistent with physical ideas. This is generally not difficult.

5. *Drawing up the storyline* in overheads or powerpoint slides that illustrate the story and contain all necessary information.

6. *Narrating the story*, that is, giving the class. It is not always possible to anticipate all details of a story or to anticipate questions, so the narration is often improvisational involving side stories drawn from experience.

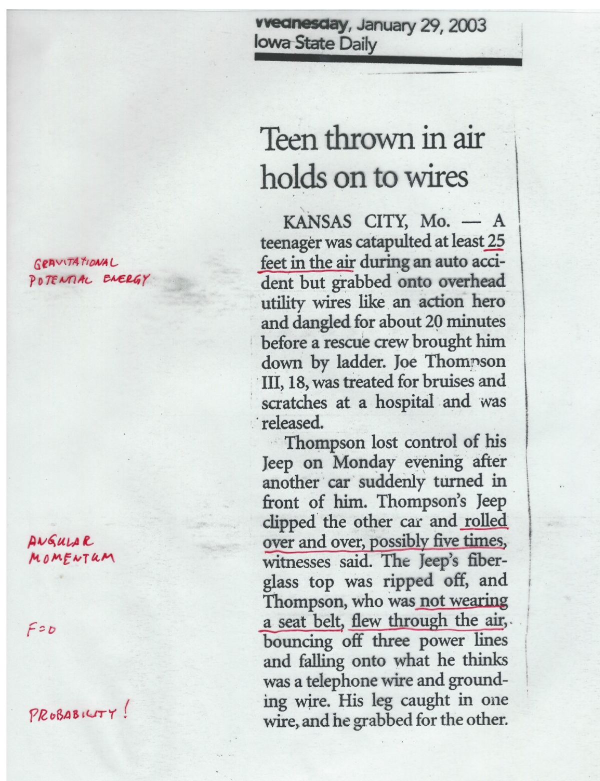
There is great benefit to science learning through story telling and, within the classroom, through a conversation.

## 3 Physics content

A required physics book for the course was Feynman's small paperback book *Six Easy Pieces,* which are six chapters from his physics course at CalTech and which contains few equations and shows that all subjects in physics can be talked about in a conversation. We will briefly illustrate the style and content with the following examples, followed by short notes on several other articles.

**Teen thrown in air holds on to wires** *Iowa State Daily*, Jan. 29, 2003.

First, we read the article shown in Fig. 1 pointing out the physics issues and ideas we will be discussing. In the article, being thrown "25 feet in the air" is *gravitational potential energy.* The jeep was witnessed to have "rolled over and over, possibly five times" and this is *angular momentum conservation.* The student did not have his seat beat on, so the force on him was zero, $F = 0$, and he was a mass $m$ free to fly in whatever direction he was thrown. Finally, the comment that "His leg caught on one wire, and he grabbed for the other," and hung there for 20 minutes before the fire department arrived to take him down, can lead to a discussion of probabilities: what is the likelihood that he survived without a scratch? One can talk about



Wednesday, January 29, 2003
Iowa State Daily

Teen thrown in air holds on to wires

KANSAS CITY, Mo. — A teenager was catapulted at least 25 feet in the air during an auto accident but grabbed onto overhead utility wires like an action hero and dangled for about 20 minutes before a rescue crew brought him down by ladder. Joe Thompson III, 18, was treated for bruises and scratches at a hospital and was released.

Thompson lost control of his Jeep on Monday evening after another car suddenly turned in front of him. Thompson's Jeep clipped the other car and rolled over and over, possibly five times, witnesses said. The Jeep's fiberglass top was ripped off, and Thompson, who was not wearing a seat belt, flew through the air, bouncing off three power lines and falling onto what he thinks was a telephone wire and grounding wire. His leg caught in one wire, and he grabbed for the other.

GRAVITATIONAL POTENTIAL ENERGY
ANGULAR MOMENTUM
F=0
PROBABILITY!

Figure 1: The article in its entirety from the student newspaper, *The ISU Daily.*

the psychology of survivors and the stories they tell.

This is a perfect article to discuss the kinetic energy of the motion of the jeep before the accident, the conversion of this kinetic energy into rotational kinetic energy, the presistence of this rotation as angular momentum conservation, and the final catapulting of the student vertically into the air, whereupon he reached a height of $h = 25$ feet.

Following Feynman, the style of the classroom discussion is to do what physicists always do when observing natural events: make up a story that fits the facts. This story should be economic (not too complicated), should respect all that is known and observed and, if possible, predict something new that was not previously observed. Here is a story as illustrated in Fig. 2:

The jeep of mass $M$ was traveling at velocity $v$ and, having turned sideways, the friction of the tires on the street provided the *torque* to start the jeep rolling over. At this point, we simplify in the way that physicists always simplify, by abstracting the essential part and neglecting the complications (we can always come back later and put in all the details).

So, we replace the jeep by a cylinder of radius $R$ and tangential velocity $v$ (the same as the original velocity and the rolling over velocity). This cylinder has angular momentum (call it $L$)

$$L = \frac{1}{2} M v R$$

which will remain exactly constant (will not change) as long as no other torque is applied. Of course, some torque is applied every time the jeep bounces on the street as it rolls along, but these are bouncing torques with forces that mostly go through the center-of-mass of the jeep and that will not change the angular momentum by much.

Examples of more familiar angular momenta, such as the Earth's rotation and the Earth's orbit around the Sun where, in both cases, the constancy of the length of a day and the length of a year are very familiar.

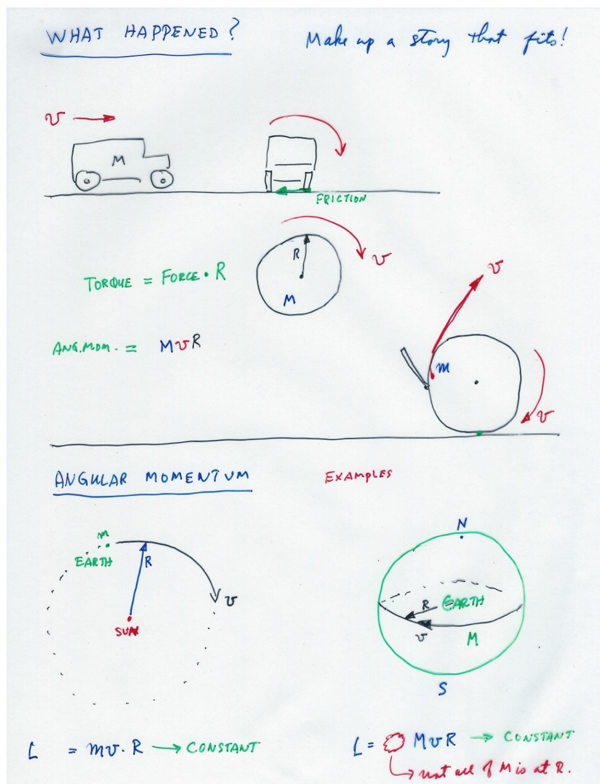



Figure 2: A story explaining what happened.

The jeep (it is reported) hit a telephone pole and the student (mass $m$) flies freely out the top in a vertical direction at the same velocity $v$.

It is now a question of how high the mass $m$ will go starting from ground level with velocity $v$. Energy conservation means that the kinetic ($KE = \frac{1}{2} m v^2$) plus gravitational potential energy ($GPE = mgh$) must be constant, so at ground level ($h = 0$ and velocity $v$)

$$KE + GPE = \frac{1}{2}mv^2 + 0$$

and at the top ($h = 25$ feet and $v = 0$)

$$KE + GPE = 0 + mgh,$$

or, $\frac{1}{2}mv^2 = mgh$. The mass $m$ cancels, and a little algebra carefully discussed leads to

$$v = \sqrt{2gh}$$

which is about $v = 14$m/s or about $v = 30$ mph. Usually in this course we try to avoid algebra, but in this case it is worth the effort.

The comment that "he was not wearing a seat belt" leads to a discussion of the reason for seat belts (to prevent you from becoming a flying object), why cars have "crush zones" to absorb an impact slowly over a long distance to allow the force on the passenger to be smaller, and why seat belts are used in airplanes.

**Thousands Die as Quake-Spawned Waves Crash Onto Coastlines Across South Asia** Amy Waldman, Madras, India, *Des Moines Register* Dec. 28, 2004.

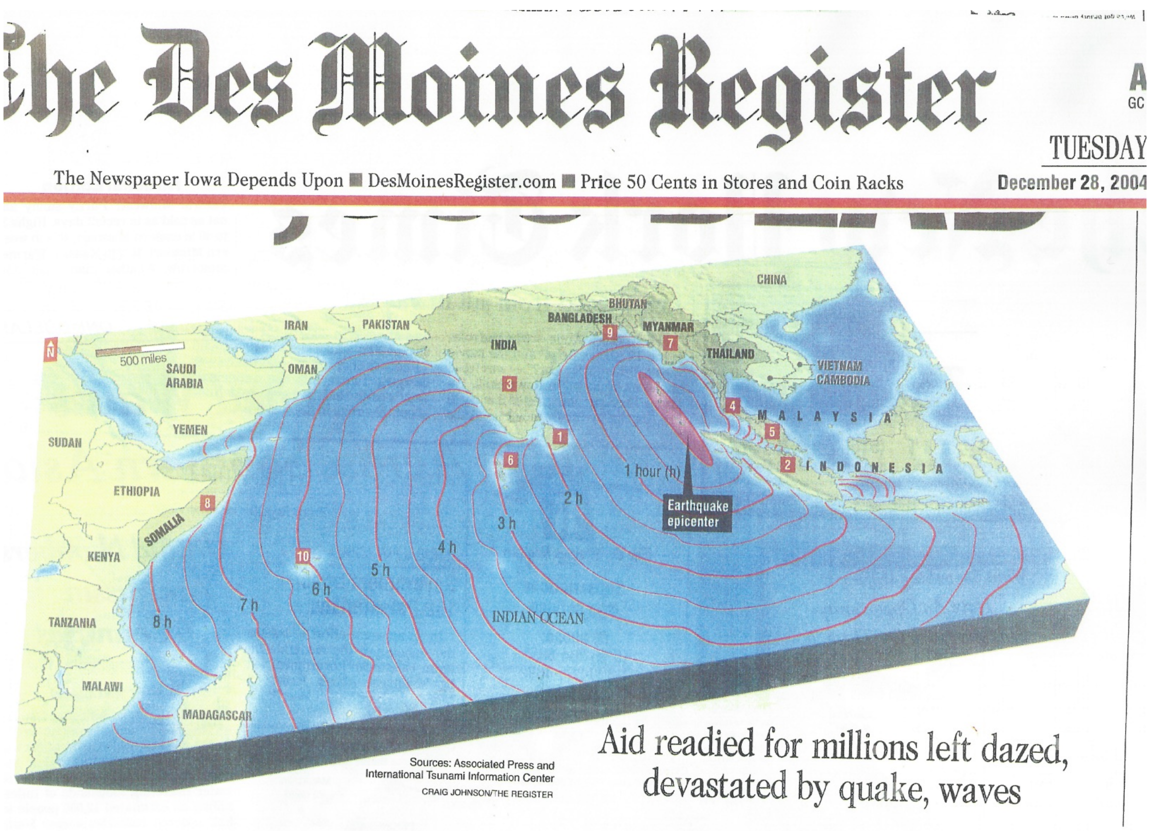



Figure 3: Wave front map of the "Christmas tsunami" that propagated a wave across the Indian ocean to Africa, Pakistan, and south to Jakarta.

The remarkable wave front map in the *Des Moines Register* shown in Fig. 3 displays all important wave phenomena: wave velocity, wave refraction near the shoreline where the velocity is lower, single slit diffraction in the narrow channel between Sumatra and Jakarta, and wave diffraction around the Indian peninsula. The wave velocity is proportional to the square-root of the depth, $v = \sqrt{gd}$, where $g$ is the acceleration of gravity, $g = 10$ m/s$^2$ and the depth is from 2000 to 4000 meters.

The wave front propagates 500 miles every hour, as seen in Fig. 3, and this velocity of 500 miles per hour is nearly constant all across the Indian Ocean. Near the shore, the velocity drops because the water is less deep and the waves refract towards the normal (just like refraction in an optical lens) and therefore approach perpendicular to the shore.

The wave diffracts about India and heads towards Pakistan, and it refracts around Madagascar and heads through the channel between Madagascar and Africa. The wave front that impinges on the narrow channel between Sumatra and Jakarta emerges on the other side as a spherical wave, an example of single slit diffraction.

All of this is illustrated by discussing refraction, diffraction, and wave velocity in optics and lenses, making these wave phenomena more accessible and understandable.

**Training Brand** Rob Walker, *New York Times Magazine*, Feb. 27, 2005.

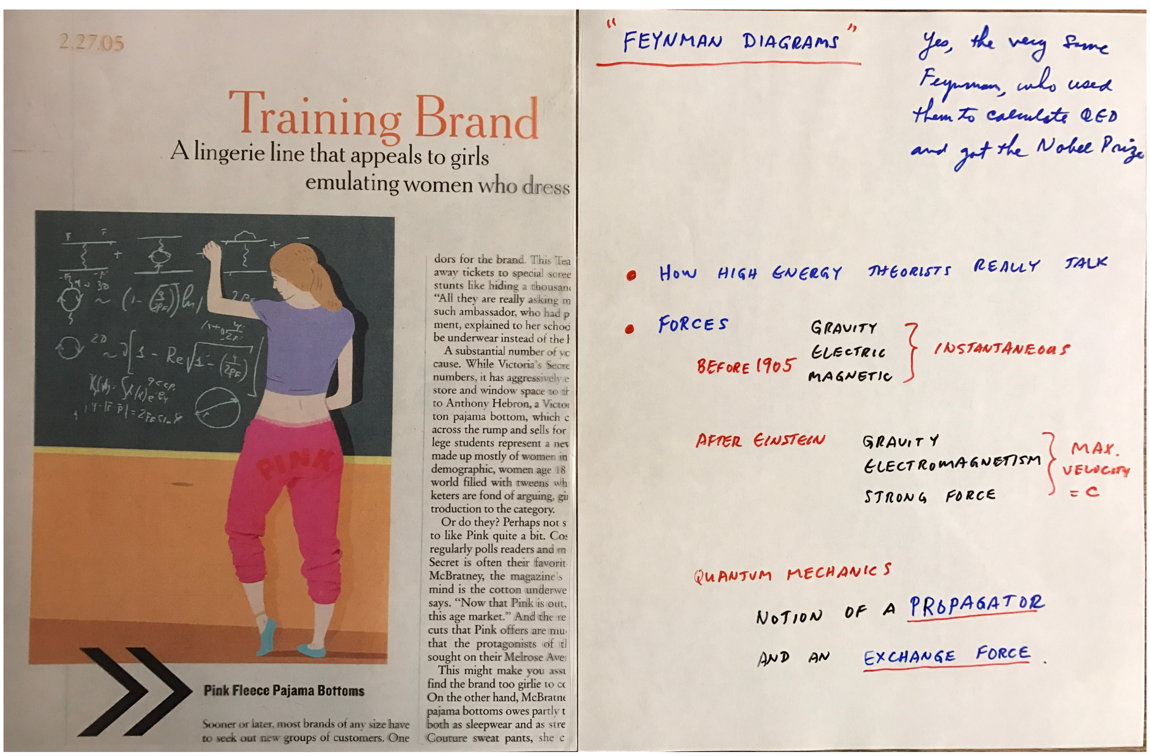



Figure 4: An ad for pajamas showing a woman writing Feynman diagrams on a blackboard. All the equations are correct. On the right is the first page of the physics discussion which covered the Uncertainty Principle, virtual diagrams, quantum exchange forces, and the idea behind unified field theories of the three main forces of Nature.

The ad for women's pajamas in Fig. 4 that appeared in the *New York Times Magazine* was a pure gift. The equations written on the board are all exactly correct and represent the way real theoretical physicists think today about the forces of nature. The physics discussion starts with the Uncertainty Principle and the idea that energy conservation can be violated for a very brief moment in time, then reestablished. The moment in time is limited by Planck's constant, which is a very very small number in our everyday physics units. This goes by the name of "quantum field theory" and this way of thinking is the foundation of modern physics and works to extremely high precision.

## 4 Out of about 550 articles

In the interests of space, we will only describe several other articles (out of a total of more than 550) generated over a period of several years teaching this course.

**Italy: 7 Go on Trial Over Quake** Ekusabetta Povoledo, *New York Times*, Sept. 21, 2011.

The L'Aguila earthquake in the mountains east of Rome on April 6, 2009 killed 309 people. Of course, this region of Italy, as in most of Japan, has experienced thousands of small tremors and occasionally large quakes for all of known memory, and the people of the region have developed habits to mitigate the loss of life – they sleep outdoors during periods, such as this three-month period from January to April 2009, in which there are repeated bursts of small tremors. A commission of experts were called upon to comment. The commission met on March 31 and, on television, concluded that a large earthquake was not imminent. The 6.3 magnitude quake happened one week later, and the scientists were charged, prosecuted and convicted of "multiple manslaughter for giving a falsely reassuring statement."

This whole episode, starting with the original article on April 6, 2009, is a story without bounds: it combines science and technology, sociology and psychology, the law and society, human emotion and tragedy, economics and risk. The students in this class are asked to write a "reflection" piece on stories like this. The questions raised here are far reaching and largely unanswerable, but require thought. What do you do if scientists claim that San Francisco will experience a huge quake during the following month? Evacuate the city? Encourage people to take vacations? Even a simple evacuation can lead to panic and a billion dollar cost.

The *New York Times* article in April 2009 shows three months of data on the number and magnitude of all the tremors. In addition to all the other issues, one can discuss statistics, statistical fluctuations, and the current state of earthquake prediction.

**The Physics of the Laboratory, And the Chemistry of the Heart** Arts section of the *New York Times*, November 28, 2011.

The stage play at the Geffen Playhouse in Los Angeles, *Radiance*, starring Anna Gunn and written by Alan Alda is a dramatic piece about the personal life and science of Marie Curie in Paris.

**How not to stop a runaway truck** *Des Moines Register*, August 20, 2011.

A short article about a guy and his pickup truck without brakes. He thinks he can stop by dragging his foot on the street to slow down the truck. It's funny, and a good way to discuss the work-energy theorem and how a (friction) force times a (stopping) distance will change the (kinetic) energy of a truck down to zero (stopped).

**Campus police use stun guns to help protect officers, public** *ISU Daily*, Feb. 18, 2005.

This article is one of several on the use of tasers and leads to a discussion of DC (direct current) circuits, the power in an electrical circuit, and the energy delivered to a person. We use ohm-meters to measure the skin resistance of students in the the class, estimate the energy dumped into a person, and the sometimes fatal result.

**A Planet 'Just Right' for Life? Perhaps, if It Exists** New York Times, Aug. 21, 2012.

This is a discussion of a possible "Goldilocks" planet that is not too hot, not too cold, but just right for life. The concept of a "habitable zone" in a solar system and, in general, the conditions that allow life to be supported on a planet can be discussed at depth.

**Interstate deaths up since Iowa increased speed limit** *Des Moines Register*, September 12, 2012.

Accidents statistics are a good way to discuss Poisson statistics and the expected fluctuation of the "square-root-of-N" ($\sqrt{N}$) when the mean value of a random variable is $N$. Few journalists seem to understand statistics and these discussions (every year a similar article is printed in the local newspaper) are rich in numbers and data.

**British Government Seeks to Suppress Dissident's Alleged Spy Links** *International Herald Tribune*, September 21, 2012.

This article is a follow-on to a prior article on the death of the Russian dissident Alexander Litvinenko who was, apparently, given a tiny dose of Polonium-210 ($^{210}_{84}Po$). Polonium was discovered by Marie Curie and named after her native Poland. Polonium is a short-half-life rapid alpha emitter ($\alpha$) and deposits a huge amount of heat, one gram generates 140 Watts of heat, and therefore is used on interplanetary probes as an on-board power source. It also dissolves in a mild acid, such as stomach acid and, therefore, taken internally it will damage all the internal organs leading to death, in fact, a death that is not familiar and has no obvious origins that a physician can recognize. This leads to a discussion of radioactivity in general and some aspects of nuclear physics.

## 5 Themes emerging from a survey

Data were collected from student focus interviews for both single classes and longitudinal groups over 3-4 years[2] These interviews were recorded and transcribed. A

[2]Kevin Saunders, Provost's Office, Iowa State University.

second source of data came from multiple informal interviews with the instructor who taught the physics portion of this class. We are planning to triangulate these data with student portfolios later. The qualitative data analysis used was thematic analysis.

**Interdisciplinary learning and teaching as synergic (from good at writing or physics to good at both):**

*"If I would take them both together it would be a lot easier. So, I signed up for it, because I hate physics."*

*"A lot of people were taking it because they dont like physics, and they are pretty good writer. I am not a very good writer, but I like physics."*

*"I still feel like a lot of the things I learned about physics I learned in Newspaper physics because we talked about it conceptually and philosophically."*

*"For me, it was the last science credit I needed I thought it was a good way to do it, because I hate mathIt was a good way to learn more about physics without having to do a lot of math."*

*"taking physics class made me nervous, because I had never taken more than chemistry in high schoolAnd, you learn that you can communicate with others via overall concepts to help them understand things"*

**Physics contents as current and big ideas (from fear to fun):**

*"... If I would take them both together [English 105 and Physics] it would be a lot easier. So, I signed up for it, because I hate physics."*

*"One of the things that helped me learn was that we focused on things that were current and fun. My favorite thing was when we talked about the nitro ice cream. We learned about how they used the conductors. They had just opened up a shop in Ankeny, where I live. I actually ended up working for them at the fair last summer. It was interesting."*

*"... the most mathematically complicated ... completely out of reach of a layperson. But, [the instructors] condensed it down to what s/he thought wed most care about ... we could all visualize that, but I am sure it is not quite that simple."*

*"... Because it is so basic, you can apply the concepts to a lot of things ..."*

**Instructional model as porous (from rigid guidelines and expectations to interesting and open-ended forums and questions):**

*"This class is not focusing on regurgitation and rudimentary. That was really appealing to me at the time."*

*"All the other classes at that point in your career are just like that: Here's the information, memorize it, and know how to use it within these guidelines."*

*"... like a perfect thinktank of idea and people that you can't get in other classes because they are so focused on a specific topic ..."*

*"... I remember being so excited that we didn't have any quizzes or test. I didn't know how they were going to grade us."*

**Learning environments as safe, diverse, and connected (from staying in a comfort zone to a community zone):**

*"I think a lot of it had to do with the fact it was a very friendly and open environment. Everybody felt comfortable sharing their thoughts on something ..."*

*"The ideas of the class are so different, because you are exposed to diverse ideas."*

*"It [the field trip to Fermi lab] helped to raise your awareness about this field that you've never known about ... and helps make you well rounded."*

*"... we felt like a huge family ... No competition ..."*

*"... Having the different opinions on how you could have structured it differently was helpful. Peer revisions provided for extra ideas."*

*"I tell any freshman that comes my way that they have to take this class ... A lot of us have had many of the same classes, so we've developed an even bigger bond."*

**First-year college students as independent thinkers (from being controlled to having freedom)**

*"... you don't have time to really think, because you know you have to get it all down for homework. But, in this class you had freedom to think for yourself and ask your own questions. It was a new thing that we had to get used to for a while."*

*"... I'd actually notice how many science articles there are. Before I'd read it and not notice those. I think the things they had us write about helped to change how I write ... A lot more thinking and pondering."*

*"... It was a different thought process. It made me wonder why all the courses couldn't be like that ..."*

*"... It helped you to strive to write a good paper that others would appreciate rather than just meeting the instructor's requirements."*

## 6 Using newspapers instead of textbooks in the high school curriculum

Newspapers are suffering greatly as the web provides free want ads and free access to simple news. The people at Google, and the late night comedy shows, are keenly aware that newspapers provide the primary information they need every day to pass on to their search engines and current affairs commentary. Without newspapers as primary information sources, all of this will weaken.

A typical good newspaper contains a couple of paperback books of text every day. The excellent newspapers of the world, such as *Le Monde, New York Times, Los Angeles Times, Chicago Tribune*, have large staffs and foreign reporters, and these newspapers seem to be "ahead of the curve" in maintaining a readership and subscribership.

We wrote a couple of articles[2, 3] on using newspapers as the main content for all high school curricula: literature, mathematics and statistics, all the sciences, history, political science, opinion, sociology and psychology, and the arts.

A good newspaper contains all of this interesting material, and it is explicitly timely. This current information draws students' attention to its direct relevance to events today, and possibly the impact of past events on current events. For example, any mention of Afghanistan could lead to watching the film "Charlie Wilson's War" with Tom Hanks, and students can be asked to look up and fill in the history of Afghanistan from Alexander the Great to the Soviet invasion to the US war against the Taliban. In almost every current news political article, you can ask "what has been left out of this article?" There is a mountain of information to be found.

The book reviews in a good newspaper are better than the easily available summaries and condensations of literature and, in addition, are more interesting and better written. The obituaries of political leaders and scientists are fascinating and often serve as a view to history.

This manner of teaching would require more of the teachers, but considering the value of being able to 'google' almost anything, the burden on the teacher can be transferred to the students, who would profit, by asking them to investigate the claims in an opinion piece, or to compare two contradictory points of view, both of which may be wrong. This level of critical thinking is essential to any democratic society and a skill among our citizenry which seems to be sorely lacking.

We hope to experiment with in-service teachers with these ideas and teaching methods during the coming year.

## References

[1] Fermilab is a major international high energy physics laboratory located in Batavia, IL. `www.fnal.gov`

[2] "Ditch the textbooks, teach from newspapers instead," *Des Moines Register*, John Hauptman, Guest column, August 28, 2010.

[3] "Out, damned book," John Hauptman, *Physics World*, August 2011.