Engaging Undergraduate Education Majors in the Practice of Astronomy through a Coherent Science Content Storyline Course

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Research questions

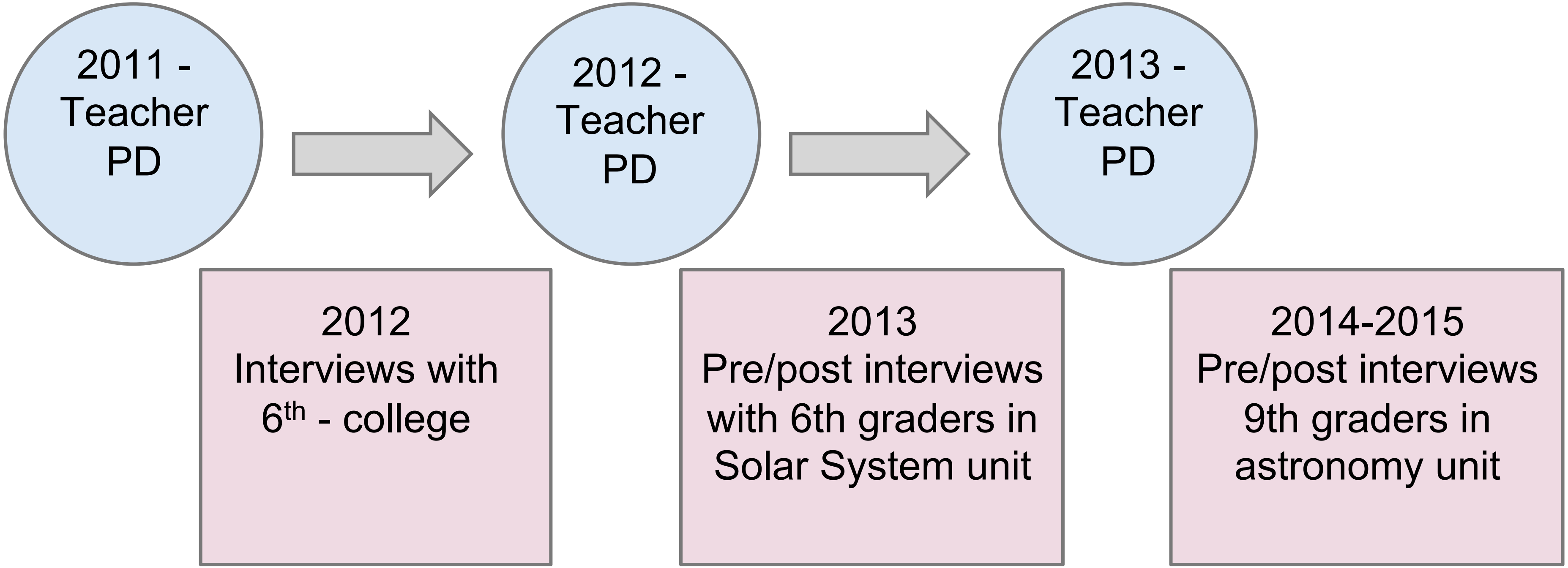
By engaging in a *coherent science content storyline* course:

1) Did future elementary teachers productively engage in science practices as they explained astronomical phenomena?
2) Demonstrate their understanding of coherent science inquiry investigations by applying this framework to a creative work of fiction?

Research to practice collaborators

- Alice Flarend
- Chrysta Ghent
- Tim Gleason
- Yann Shiou Ong
- Tim Lawlor
- Scott McDonald
- Jason Petula
- KeriAnn Rubin
- Heather Spotts
- Arzu Tanis Ozcelik
- Kyle Tener

Prior work informing development of course and research frameworks



Flarend & Palma, 2013; Plummer, Palma, Flarend, et al., 2015; Rubin, Plummer, Palma, et al., 2014a, 2014b;

Key features of the course

Coherent science content storyline

- Big Idea - There is a consensus model developed by scientists for the formation of our Solar System that is built on evidence from observations of objects in the Solar System.
- Organized around a series of investigations
  - Sequencing *coherent science inquiry investigations* using CER framework

Plummer & Tanis Ozcelik, 2015; Roth & Garnier, 2006; Roth et al., 2011; Zembal-Saul, McNeill, & Hershberger, 2012

Overview of course

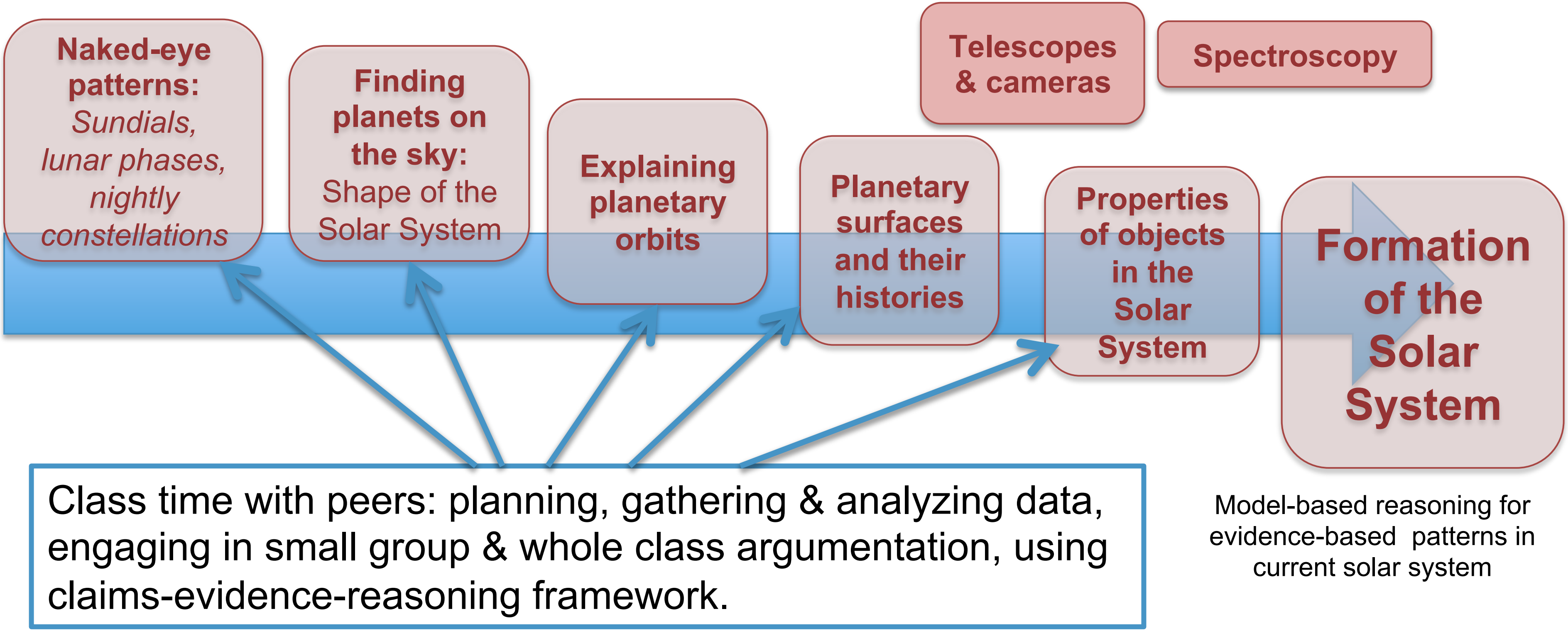
Investigations:

- Small groups & whole class
- Instructions open-ended (no lab write-ups)
- Investigations identified a pattern in the current Solar System
- Helped students understand how astronomers practice science

Culminating project: Write a children's science storybook featuring an astronomy investigation

- Co-taught (astronomy & education faculty)
- 19 students:17 female, 2 male
- 2 hour 30 min per week, 15 weeks

Coherent science content storyline investigations



Duschl & Bybee, 2014; Lehrer & Schauble, 2000

Case study

Sasha, *elementary education major*

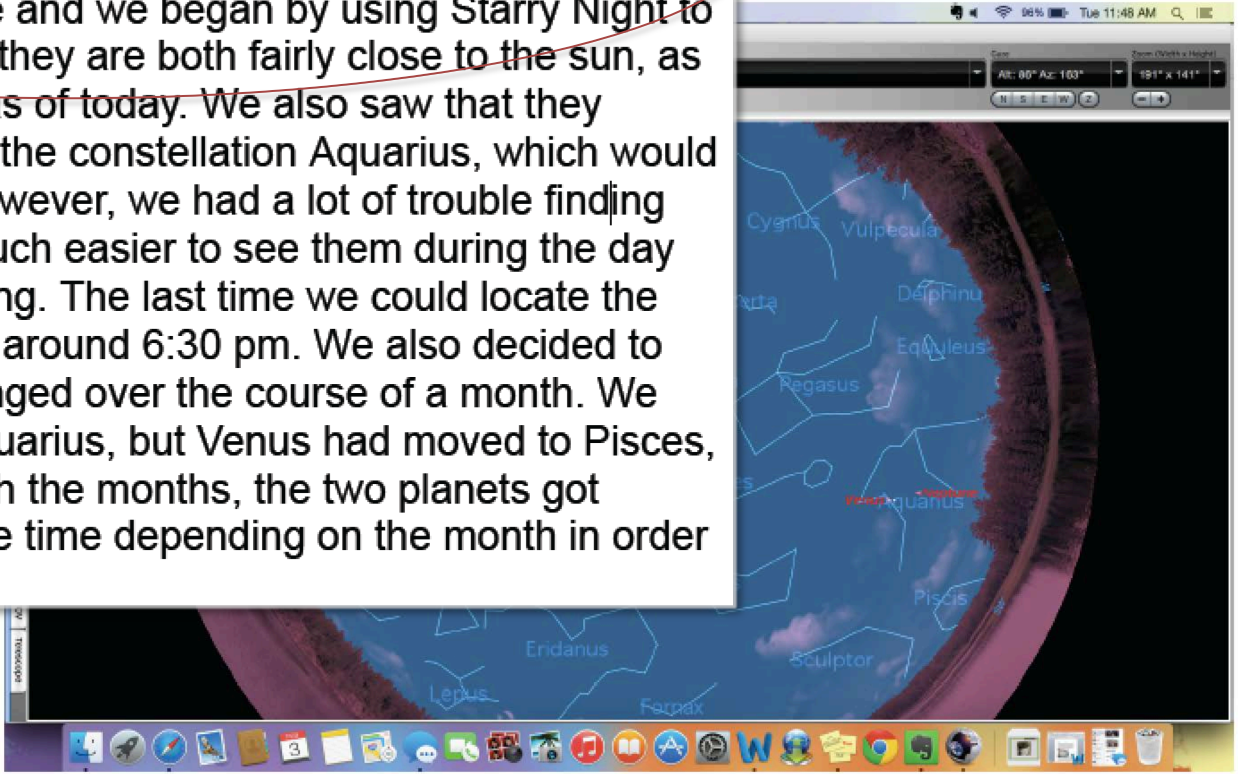
Data sources:

- Electronic science notebook
- *Reports*
- *Video from classroom investigations*
- *Culminating project*

Planets Investigation

2/3/15: Where do we find planets on the sky and how can we use this to predict future planet observations?

My group has Venus and Neptune and we began by using Starry Night to locate out planets. We found that they are both fairly close to the sun, as well as fairly close to each other as of today. We also saw that they stayed in the general proximity of the constellation Aquarius, which would be a good way to locate them. However, we had a lot of trouble finding the planets at night, and it was much easier to see them during the day which I thought was very interesting. The last time we could locate the constellation and the planets was around 6:30 pm. We also decided to see how the planets position changed over the course of a month. We saw that Neptune stayed near Aquarius, but Venus had moved to Pisces, and as we continued to go through the months, the two planets got further away. (we had to adjust the time depending on the month in order to see both planets)



February

Planets Investigation

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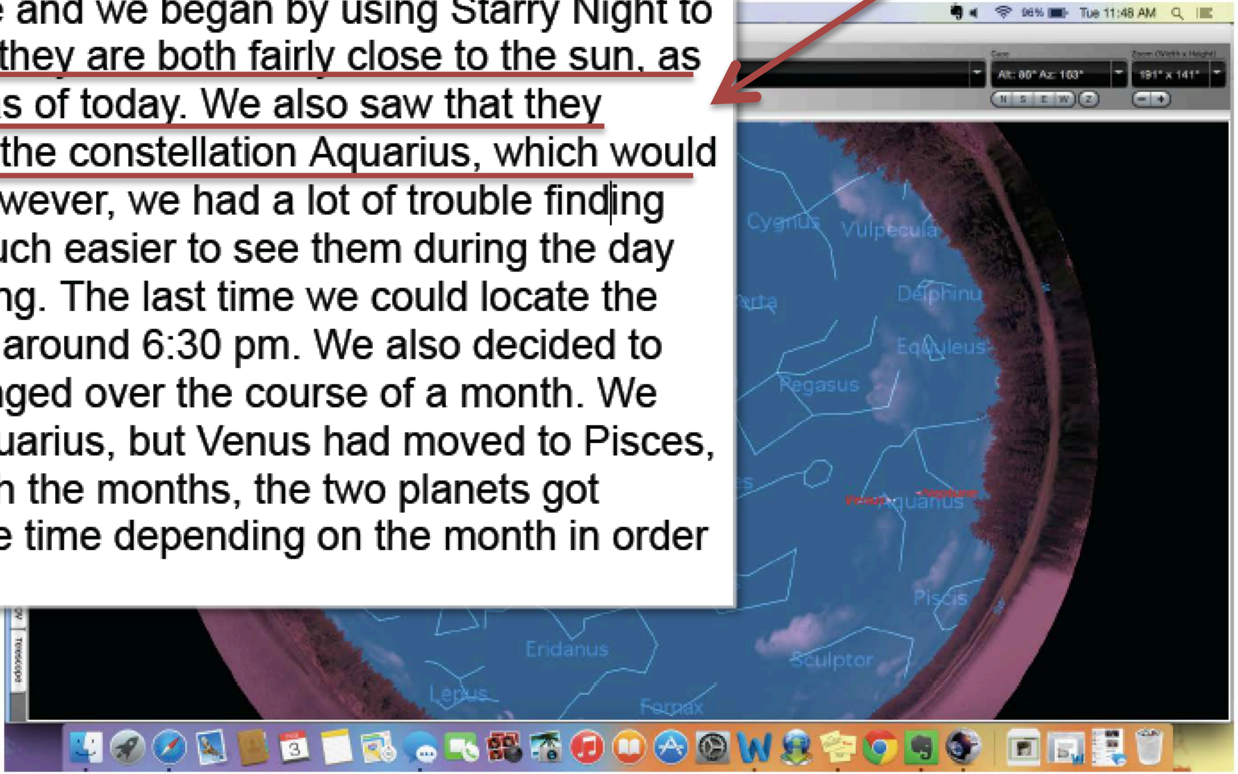
Early claim based on initial data



February

In order to answer the second half of our investigation question we need to track out two planets on 10 different dates. This would gave us the ability to accurately estimate where our planets may be in the future and see how they change throughout 10 different dates. I decided to check the planet once every month, to see just how much it changes in that time period. I may encounter days where it won't be visible exactly a month away, and in that case I will go to the closest day that the planets are visible. I will also try to keep the time the same everyday, but can adjust that if needed.

Describes her group's data collection plan

Venus	Neptune
February 3 2015 12:15pm In Aquarius Altitude: 32 degrees Azimuth: 147 degrees	February 3 2015 12:15pm In Aquarius Altitude: 35 degrees Azimuth: 152 degrees
March 3 2015 12:15pm In Pisces Altitude: 44 degrees Azimuth: 134 degrees	March 3 2015 12:15pm In Aquarius Altitude: 39 degrees Azimuth: 183 degrees

Data collection table for 10 dates

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Sasha's group develops claim and evidence based on initial data

She also offers tentative <u>reasoning</u> for *why* these patterns are occurring

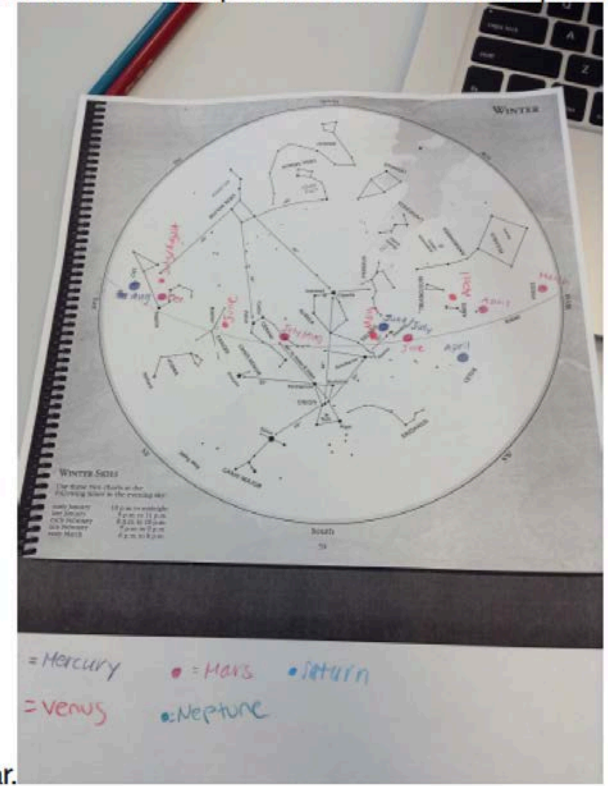
Venus Neptune

Claim: We will always find the planets in a constellation in the Zodiac. In other words, they will follow constellations on the ecliptic line. Neptune always stays within Aquarius and Venus shifts between multiple constellation on the Ecliptic Line.

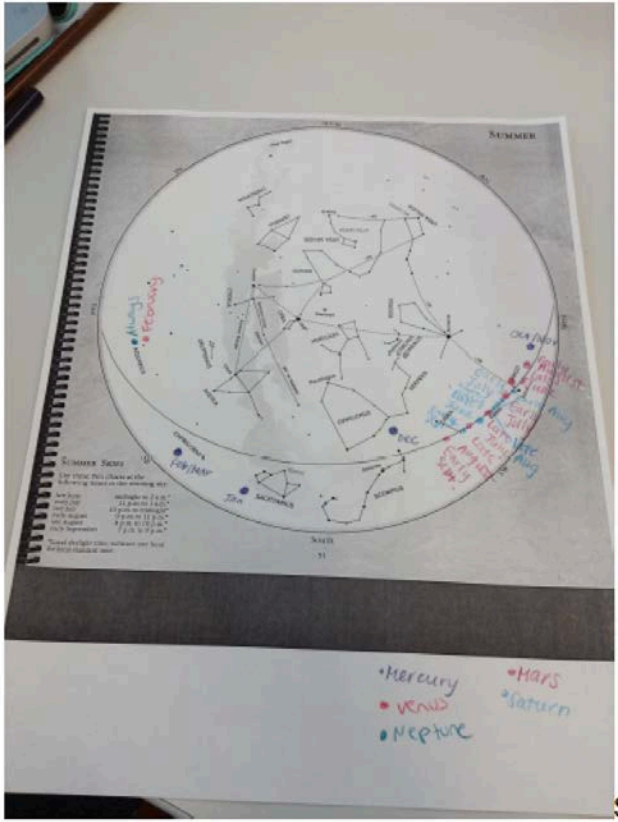
Evidence: From my table, I was able to confirm that Neptune never leaves Aquarius, making it very easy to locate when that constellation is visible. Neptune also moves at a fast pace, allowing it to stick to Aquarius as it appear to move throughout the sky. I wonder if this means that Neptune rotates at a similar rate that earth does, making it appear to almost never move from Aquarius. Venus on the other hand is a little less predictable, and rotates throughout multiple constellations. However if you look at a map of the entire sky, with constellations, it becomes obvious that Venus starts in Aquarius (in January) and then slowly moves across the Ecliptic, shifting from constellation, to constellation.

2/10/15: Today we switched up our groups in order to make sure everyone had didn't data for different planets. I worked with people who had Mars, Mercury and Saturn, which added to my data from Venus and Neptune. We used a map of the constellations to plot where

Moved into a groups with data from all 5 visible planets to plot all group's data



our planets are throughout the year.



So

and not on the other, showing us how the constel

Claim: All the planets more along the ecliptic line, staying in constellations of the zodiac. This would give someone the ability to locate a planet as long as they had the knowledge of the specific constellations.
Evidence: Our constellation maps with our planets plotted gives us plenty of evidence to prove our claim. All of our 5 planets followed this line, proving they will always be there. In order to further prove this, we also created a model in class to simulate where the constellation and planets were in relation to the sun and earth. First we put our sun (a giant yellow foam ball) in the center of a room on a table. Next we took one of the beads that was being substituted for a planet and decided it would be Earth. We placed Earth behind the su
(from my perspective) and decided to simulate a situation
appear in the sky if it was 12am in State College. First we

planet would be, and as we got down the list of planets, each one for further awa
end, we had a very basic model of what the solar system would look like. From t
able to come to the conclusion that the planets have to orbit around the sun, cre
ecliptic line, and giving us a way to always locate them.
Reasoning: The reason this evidence proves our claim is because each time we s
locate any one of the planets, it was always on the ecliptic line and in a constella
zodiac. Our evidence shows multiple examples of this, proving it occurs more tha
giving us plenty of data to prove our claim.

Evidence of *coherent science inquiry investigation* in children's astronomy investigation storybook

Multiple elements of the investigation are missing or incomplete.	Some connections are made between the investigation question and elements of the investigation. Some investigation elements are missing.	Connections are made between the investigation question and most elements of the investigation. Some connections missing or unclear; some elements may be incomplete.	**Story makes explicit connections between an investigation question, methods of data collection, and an evidence-based explanation (with reasoning) that answers the original question.**
0	11% (2)	44% (8)	**44% (8)**

One student did not submit final storybook assignment.

Including Sasha's children's book

Conclusion

- As in studies of long-term coherent science inquiry investigations with children (e.g. Lehrer, Schauble, & Lucas, 2008; Metz, 2011), preservice teachers can productively engage with peers in the practices of astronomy through a coherent science content storyline
- Promising results for future elementary teachers as many implemented coherent science inquiry investigations in writing astronomy storybooks for elementary children

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