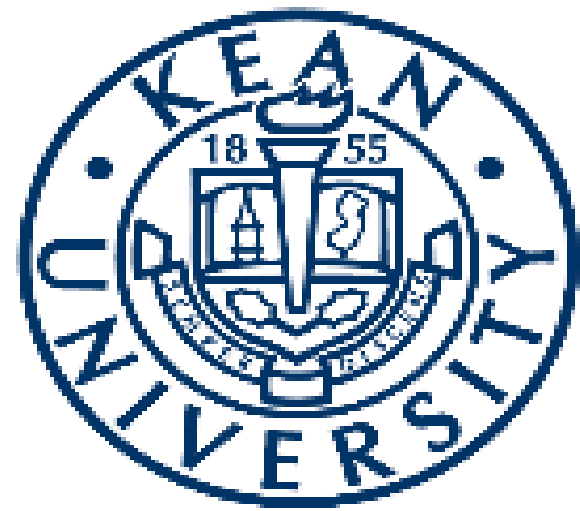# Designing and Evaluating a Cybersecurity Curriculum

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Introduction

Widespread use of internet devices by teenagers is increasing their cybersecurity risk. High schools want to increase student awareness of cybersecurity risk with a curriculum that engages the student's interest in a highly technical topic. The research question investigated here seeks the most engaging way to teach cybersecurity to high school students to raise awareness.

The students selected for the study were part of Project Adelante, a pre-college program at Kean University designed to increase the number of Hispanics/Latinos graduating high school and continuing to college. Researchers developed and delivered lectures to the students weekly, observing that each lecture and activity caused a different reaction and interest level depending on the way the topic was approached.

Results from this research show the best way to engage 14-16 year-old students in cybersecurity education topic, while providing teachers with tips, advice, and strategies to adopt when developing lesson plans. An 8-week curriculum was prepared, with engaging topics in cybersecurity providing an entry point for different learning styles. Active learning activities and student outcomes show the validity of this approach, as do pre- and post-test assessments.

Methods

Students were assigned to one of two groups based on their high school class. Freshmen were placed in the non-technical group and sophomore participants were placed in technical group (Fig. 1). A pre-assessment was used to evaluate the participants knowledge in the field of cybersecurity. The pre-assessment also served as a baseline to determine which instructional method was preferred.

Towards the end of the curriculum participants were evaluated using a post-assessment in topics such as encryption, decryption, phishing, and cybercrime that were taught.

- Nontechnical group materials used:
    - PowerPoint slides and worksheets
- Technical group materials used:
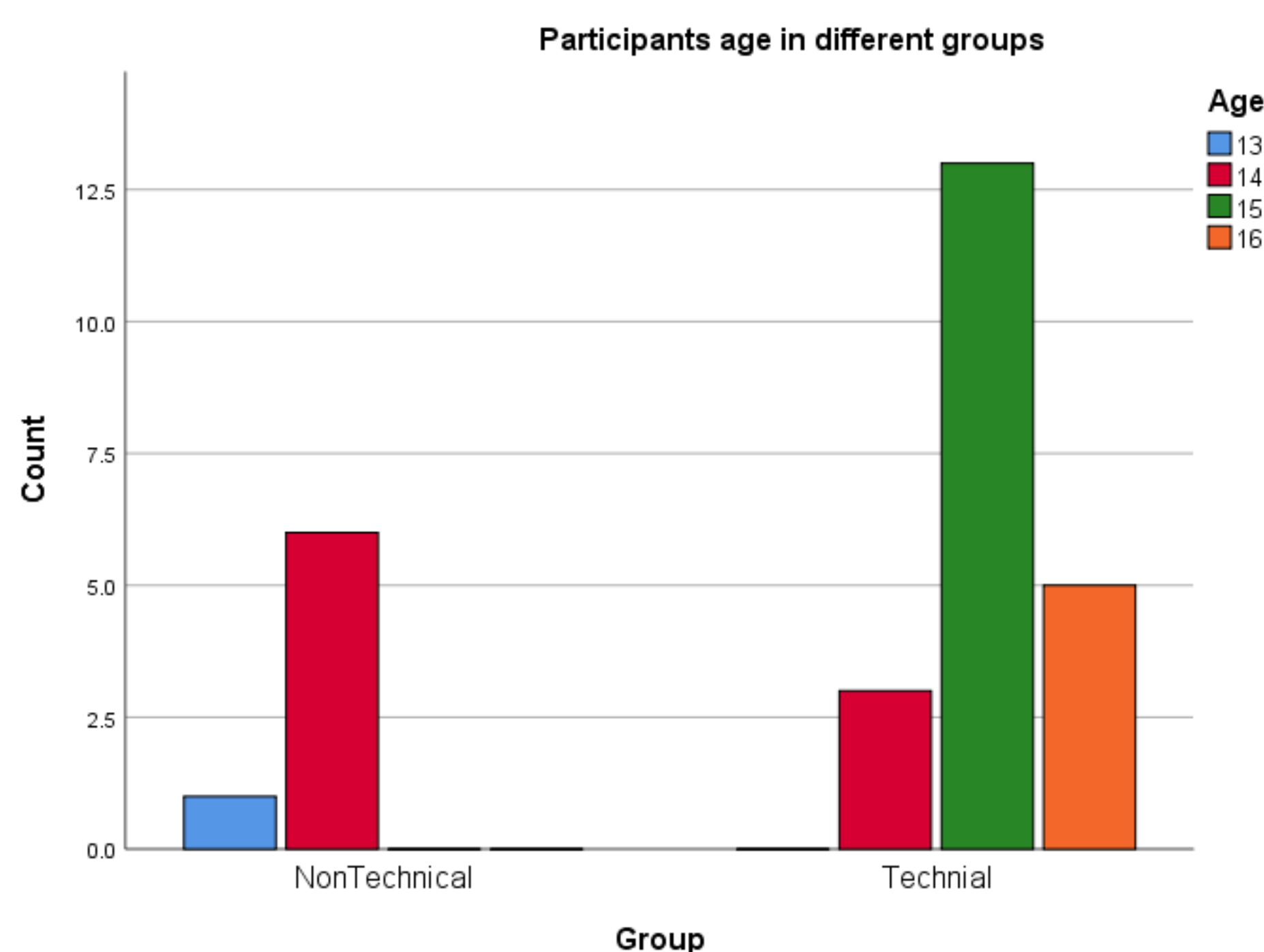   - PowerPoint slides, visual aid(videos, images and group activities)

Fig. 1. Number of participant by age and group.

Methods (cont.)

Count		Response				
		Bart's private key	Bart's public key	Kim's private key	Kim's public key	Total
Group	Non-Tecnical	1	1	2	2	6
	Technical	5	1	8	1	15
Total		6	2	10	3	21

Table 1. Responses to question 6 (Post-Assessment)

Table 1 shows responses to question 6 from the post-assessment: A network requires a secure method of sharing encryption algorithms over a public network. Which of the following is the BEST choice?
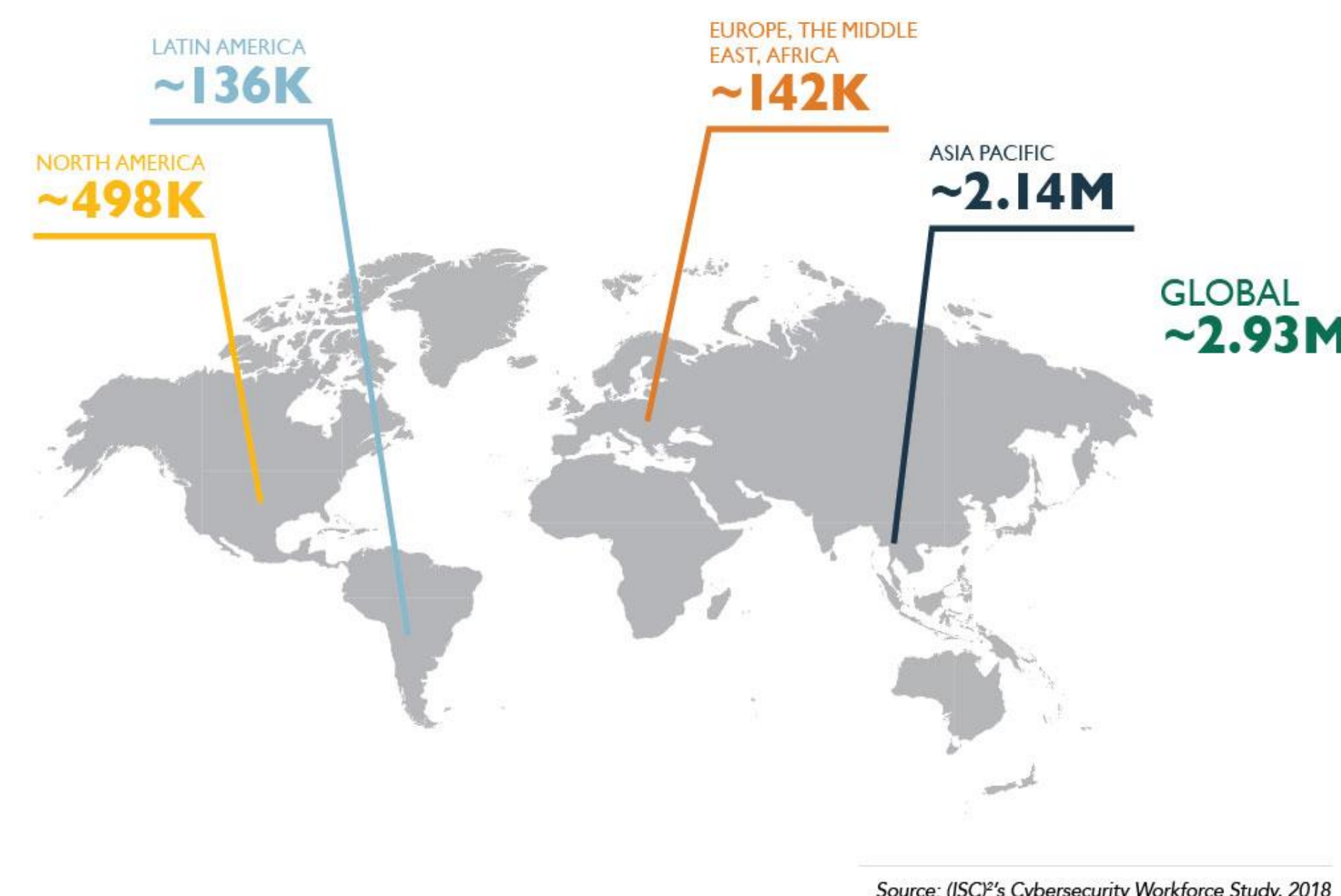
Source: (ISC)²'s Cybersecurity Workforce Study, 2018

Fig. 2. Global need for cybersecurity skills

Observations

Researchers observed that topics like encryption and decryption were too technical for use as introductory topics for high school students without previous knowledge in cybersecurity education. The 6th lesson (swatting) was one of the lessons that students seemed to be more interested in, followed by cryptocurrency and cybercrime; these lectures had two things in common: 1. Visual aids (videos and images) and 2. Strong relationship to their daily lives as high school students.
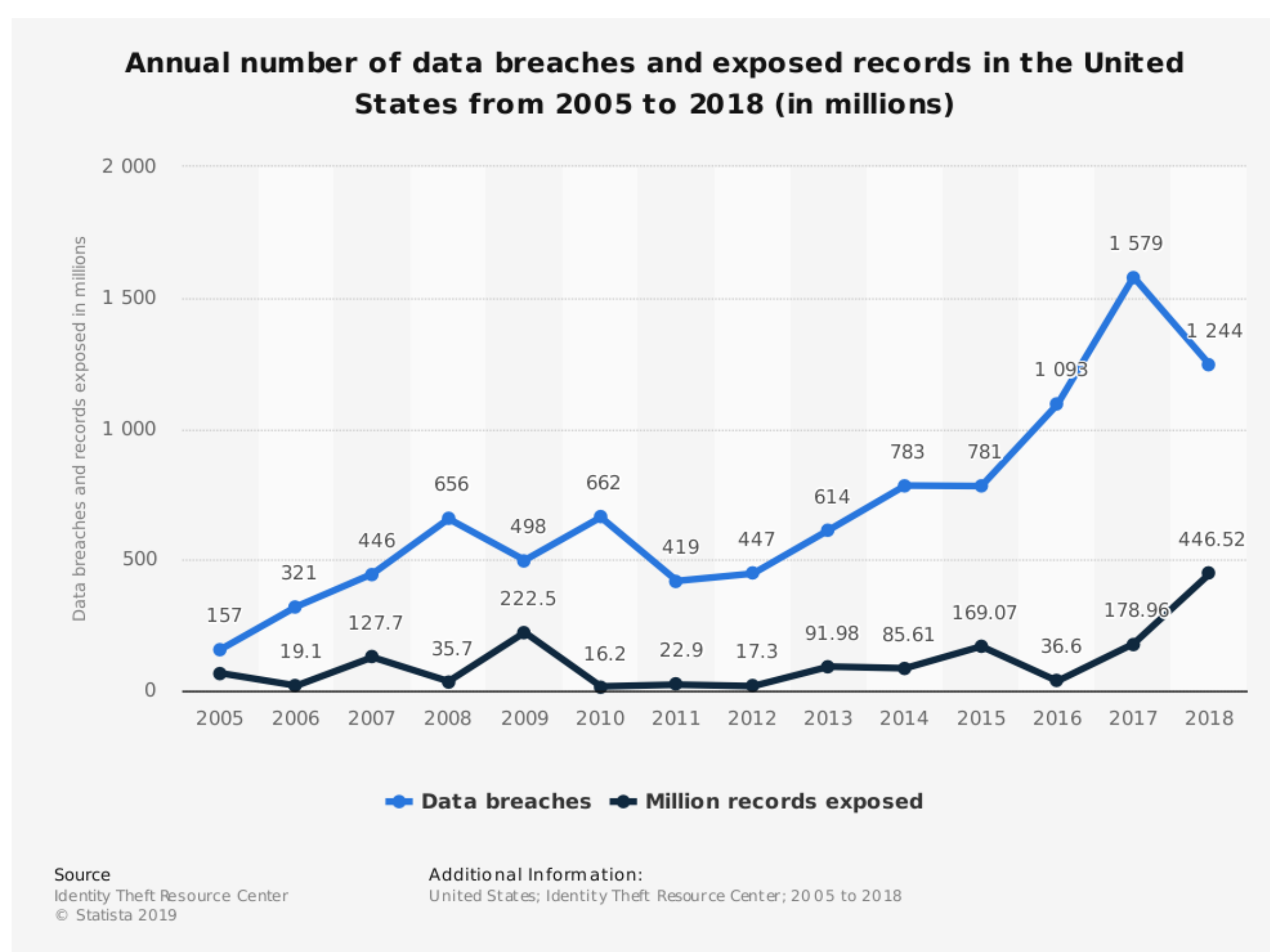

Fig. 3. Data breaches and exposed records (USA, 2005-2018)

Week	Topic
0 (September 29, 2018)	Briefly discussed with students Cybersecurity curriculum and handed out consent and assent forms.
1 (October 6, 2019)	Cybersecurity and Ethics (Pre-assessment)
2 (October 13, 2018)	Encryption & Decryption
3 (October 20, 2018)	Phishing
4 (October 27, 2018)	Cybercrime and legal consequences
5 (November 3, 2018)	Virtual Private Networks and Cyber Privacy
6 (November 10, 2018)	Swatting (Day 1 of post-assessment)
7 (November 17, 2018)	Transition from (Day 2 of post-assessment)
8 (November 24, 2018)	Thanksgiving Recess
9 (December 1, 2018)	Cryptocurrency (Last day)

[Cybersecurity curriculum overview]

Table 2. Cybersecurity education curriculum for high school students

Conclusions

To retain student engagement and interest in cybersecurity concepts when developing a curriculum and choosing lesson plans, it is recommended to use as many visuals (PowerPoint presentations, videos, video game demonstrations) as possible, and to approach topics in a way that is relevant to the students' age groups (video games, friends, family, competitions). Also, leaving highly technical topics for the middle or end of the program is preferred so that students are already familiar with relevant background information.

Acknowledgements

References

[1] "Cybersecurity Skills Shortage Soars, Nearing 3 Million," (ISC)² Blog. [Online]. Available: https://blog.isc2.org/isc2_blog/2018/10/cybersecurity-skills-shortage-soars-nearing-3-million.html. [Accessed: 04-Apr-2019].

[2] "U.S. data breaches and exposed records 2018 | Statistic," Statista. [Online]. Available: https://www.statista.com/statistics/273550/data-breaches-recorded-in-the-united-states-by-number-of-breaches-and-records-exposed/. [Accessed: 05-Apr-2019].