Leveraging Learning Theory to Improve the Effectiveness of Cybersecurity Education

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MOTIVATION

Current research in cybersecurity education focuses on instructional content, tools, and frameworks, while rarely considering learning theories that have been successfully applied in other fields.

Preparing cybersecurity students to perform well against highly skilled adversaries requires optimizing the instructional design of cybersecurity courses.

This can be done by leveraging theories from educational psychology and assessment of learning outcomes.

LEARNING THEORIES

Social Constructivism
Knowledge is constructed by learners as they process new experiences and interact with other learners.

Intrinsic Motivation
Learning is enhanced when learners engage in an activity to seek internal rewards (such as enjoyment) rather than external rewards (such as a grade).

Zone of Proximal Development
Effective learning takes place within a range of difficulty, above which a learner experiences frustration and below which they experience boredom.

EXAMPLES

Online Worksheets
Constructivism: worksheets can be designed to require active participation such as filling in blanks, multiple choice questions or short written responses. This level of engagement promotes attention and knowledge construction.
Intrinsic motivation: worksheets with elements of novelty, surprise, or uncertainty can pique learners' curiosity. This can be achieved through interesting scenarios, real-world applications, or thought-provoking questions. Allowing learners to select topics, choose pathways, or personalize aspects of an assignment can promote autonomy and increase engagement.

Programming Assignments
Constructivism: Projects that involve collaboration, peer feedback, and interactive elements promote social constructivism, group learning, knowledge sharing, and the exchange of ideas among learners.
ZPD: Providing appropriate scaffolding, such as step-by-step instructions, examples, or mentorship, supports learners in tackling challenges beyond their current abilities and promotes optimal learning.