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From Paper to Platform: Evolution of a Novel Learning Environment for Tabletop Exercises

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Why Use Tabletop Exercises (TTXs)?

- **Effective** for **learning** to **solve complex** practical **problems** in a team.
  - Team **problem-solving skills** are **essential** for computing undergraduates.
  - Crucial in fields like **cybersecurity** and **IT governance**.
  - Yet, TTXs are **not widely used** in universities.
- TTXs focus on **communication**, **coordination**, and **collaboration** (non-technical skills).
- They are typically conducted using **pen** and **paper** or simple **office software**.
- **INJECT Exercise Platform** (IXP) is a web-based **tool** that enhances traditional **TTXs**, providing automated insights into **student interactions**.
- **Data-driven insights** in IXP enable detailed analysis and comparison of team performance and behavior, **improving educational outcomes**.


Zvolte číslo vašeho týmu.
Hodně štěstí a zábavy!
Známá chyba: nepřijde žádná odpověď na vaši akci (např. při použití nástroje) – obnovte okno prohlížeče.
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Goal of the Paper

***Transition** the **TTX format** into the **INJECT Exercise Platform** (IXP), which automates repetitive tasks for instructors, allowing more time for teaching.*

We share our **experience** in **developing** and **deploying IXP** in computing classes and analyze student data.

Two **research questions**:

1. What types of **insights** about **student behavior** and **learning** can the IXP deliver?
2. What is the **instructors' teaching experience** from the exercise runs?

Transitioning TTXs: From Pen-and-Paper to Online Platform

Pen-and-Paper TTXs

- **Lightweight** in-person or online **TTXs** using **pen** and **paper** or simple **online SW**.
- Advantage: **low cost** and **low barrier to entry**.

Software for TTXs

- **TTXs** are widely used in the **cybersecurity context**, prompting the SW development.
- Most **SW** solutions are **simple**, **tailored** for **specific scenarios**.

Data Analytics in TTXs

- Most publications **lack learning analytics** of TTX data.
- They primarily address **exercise feedback** rather than educational impact.

TTX Delivery – Proposed Exercise Format

Participant Roles

- TTX **participants** = **designers**, **instructors**, **trainees**.
- **Trainees** are **grouped** into **teams**. Each member may have a **different role**.

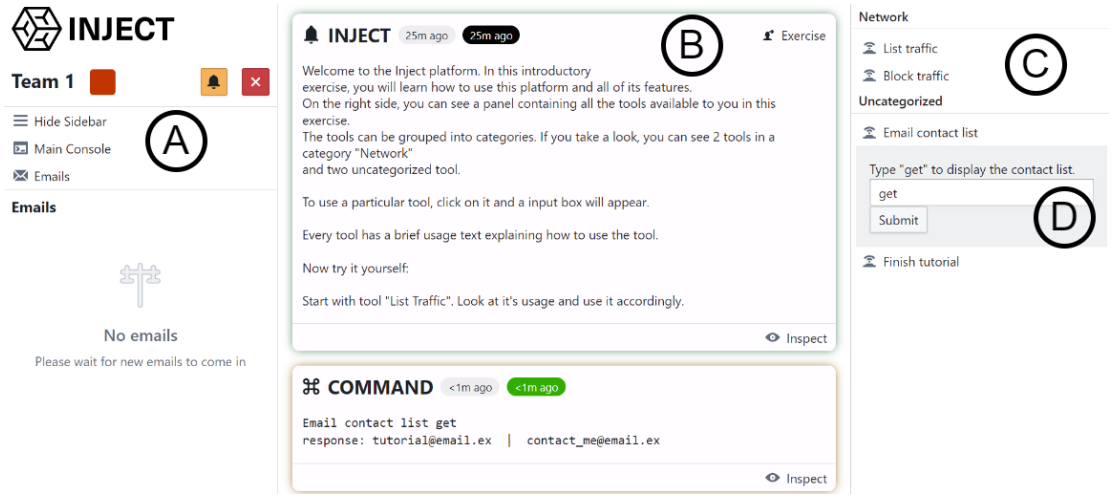
Exercise Components

- **Injects** are pre-scripted **messages** used to prompt actions and **advance scenarios**.
- **Tools simulate** real **applications** for trainees. **Milestones** mark team **progress**.

Exercise Workflow

- **Injects** are provided **manually** or **triggered automatically**.
- Each **team** progresses **independently** of other teams.

TTX Delivery – Exercise Platform



TTX Delivery – Exercise Content Example

Learning Objectives

- **Authentic learning experience** – the TTX is designed around a **real cyber attack**.
- Learning objectives are **incident triage**, **response**, and **mitigation** of impacts.

Story

- Trainees role-play as members of a **Computer Security Incident Response Team**.
- The team is responding to a **phishing attack** affecting university employees.

Available Tools

- Trainees **use tools** or make **managerial actions** such as notifying responsible parties.
- Only **one person** per team can **interact** with the IXP **tools** at any time, after the **members consult** and **mutually agree** on their progress.

Deploying IXP in Computing Classes – I

Course Context

- The TTX is a 2-hour **capstone activity** for the semester-long course "Cybersecurity in an Organization" at Masaryk University.
- Course graduates are expected to **understand** the **work** of a **security team** (CSIRT).

Field Studies

- Evaluating data and experience from **3 TTX sessions**.
- **Evolution of IXP software** readiness over **3 years**.
- All sessions conducted **in-person** within the **same course**, stage of the semester, and **exercise format**, ensuring fair comparisons.
- **Platform evolution** – **pen-and-paper** simulation on Microsoft SharePoint (Run 1), **first prototype** of IXP (Run 2), and the **latest enhanced version** of IXP (Run 3).

Deploying IXP in Computing Classes – II

Research Ethics and Data Privacy

- IXP **does not store** identifiable **personal information**, ensuring trainees' anonymity.
- Exported **data are anonymized** and cannot be linked to specific individuals.
- Post-exercise **surveys are voluntary and anonymous**, respecting trainees' privacy.

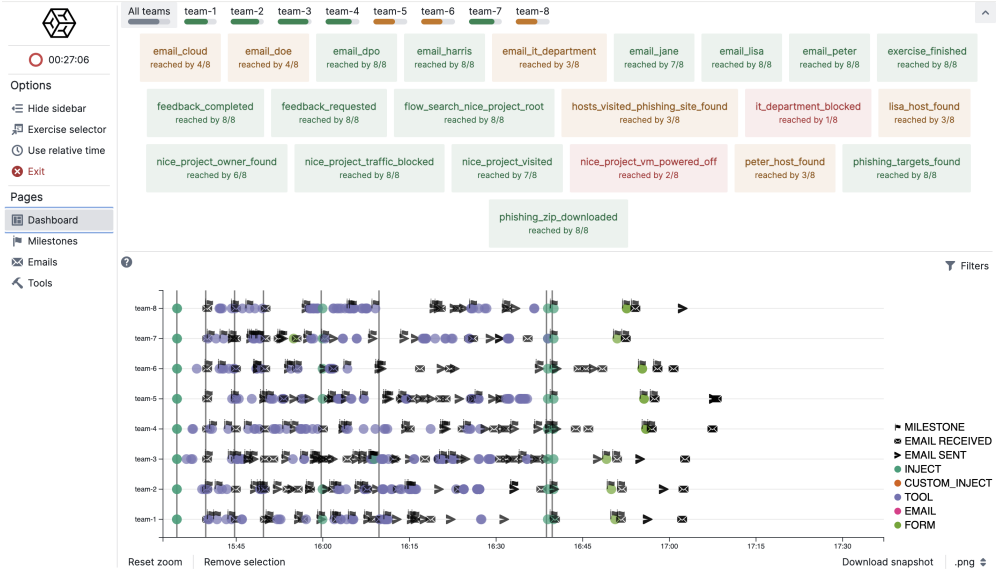
Exercise Data Collection

- IXP automates the collection of **exercise metadata** and **trainee actions** since Run 2, stored in **JSONL format** with microsecond **timestamps**.
- **Logs** include **inject receipts**, **email communications**, **tool actions**, and **milestones** categorized per team.

Automated Analysis of Trainee Data – Python Scripts

- Compare analyses of **Run 2** and **3 data** (Run 1 did not provide logs).
- Teams in Run 2 had **14 milestones** to achieve, **averaging 10 milestones reached** (71%), with only 2 out of 9 teams scoring below average.
- Tool use varied. The least successful team used tools only 6 times. A team with the second lowest milestones had high tool usage.
- In Run 3, teams **averaged 8 of 14 milestones** (57%) – a **post-exercise debrief could highlight missed actions** for better learning.
- Run 3 provided the teams with **11 tools** (additional 4 compared to Run 2).
- Teams averaged 6 email threads, with the **most communicative team** reaching the **most milestones**, highlighting the **importance of active communication**.

Automated Analysis of Trainee Data – Dashboard



Learning and Teaching Experience From Using IXP – I

- IXP's automatic **data** collection and analysis:
  - **Valuable findings** that are **hard to obtain with** traditional **pen-and-paper TTX**.
  - **Enhanced logging** and **additional milestones** in Run 3 $\rightarrow$ **deeper insights** into difficult **milestones** and **tool usage** errors compared to Run 2.
- Additional survey with 36 learners:
  - 35 found the **TTX scenario realistic**.
  - 29 found it **beneficial for incident handling**.
  - 31 expressed satisfaction with IXP's **ease of use**.

Learning and Teaching Experience From Using IXP – II

- Challenges:
  - **trustworthy in-exercise emails**,
  - basic e-mail client lacking typical features,
  - **timing** of **instructor interventions**.
- IXP for Run 2 improved reliability by **eliminating errors from shared document** use.
  → Preventing accidental overwriting and instructor confusion.
- IXP for Run 3 increased involvement by allowing **more, smaller teams**.
  → Giving **individual students** more opportunities to speak and **participate actively**.

Conclusions

- **TTXs innovate computing courses** by enabling collaborative problem-solving in cybersecurity, IT governance, and applied informatics.
- The **IXP simplifies TTXs** by automating repetitive tasks, allowing instructors to **focus on facilitation** and **supporting educational research**.
- **IXP** is **released** as open-source **software**, with an **example exercise** at **https://inject.muni.cz**.

Read the full paper at https://doi.org/10.1145/3649217.3653639

Thank you! Questions and feedback are welcome.

Stay in Touch

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INJECT Exercise Platform for Tabletops

https://inject.muni.cz

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