Continued Assessment of iNewton for the Engaged Learning of Engineering Dynamics

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Introduction

Teacher-Centered

Expository teaching: knowledge passively transmitted from professor to student (e.g. lecturing) [1]

Student-Centered

Discovery learning: student constructs knowledge by gathering/synthesizing information (e.g. active learning) [1]

Undergraduate students will explore engineering dynamics concepts using MEMS inertial measurement unit (IMU) technology called interactive-Newton (iNewton) (Fig. 1)

Table 1: Project design to systematically scale up iNewton learning intervention in an otherwise traditional (lecture-only) dynamics course (MECHENG 240).

Level	Intervention (progress to date)	Description
1	Demonstrations (complete)	Instructors demonstrate experiments in class for students
2	Prescribed Experiments (complete)	Students conduct two pre-defined experiments outside class
3	Student Created Projects (in progress)	Students propose and conduct experiments of their own imagining (with instructor feedback) outside class

Hypothesis: iNewton will positively affect: **1)** conceptual understanding, **2)** self-efficacy, **3)** intention to persist, and **4)** feeling of inclusion

Results

Table 2: Mean (standard deviation) of scores on the DCI at the beginning of the semester (pre), end of the semester (post), and overall gain (defined in [4] as (post-pre)/(100%-pre)).

	pre %	post %	gain
Demonstrations	44.5 (16.6)	51.7 (18.8)	0.12 (0.29)
Prescribed Experiments	43.6 (17.4)	50.8 (19.5)	0.13 (0.26)

Table 3: Means of normalized Likert scale values for pre, post, and gains in LAESE subfactors (engineering self-efficacy (ESE), course-specific self-efficacy (CSE), feeling of inclusion (INC), intention to persist (PER)).

	Demonstrations			Prescribed Experiments		
	pre	**post**	**gain**	**pre**	**post**	**gain**
ESE	0.87	0.86	-0.01	0.87	0.84	-0.02
CSE	0.80	0.78	-0.02	0.82	0.77	-0.05
PER	0.92	0.94	0.02	0.93	0.94	0.01
INC	0.73	0.71	-0.02	0.71	0.71	-0.01

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Methods

Figure 1: An iNewton with sensor-fixed frame of reference etched on top. It contains a triaxial accelerometer and angular rate gyro, which measure linear acceleration and angular velocity, respectively.

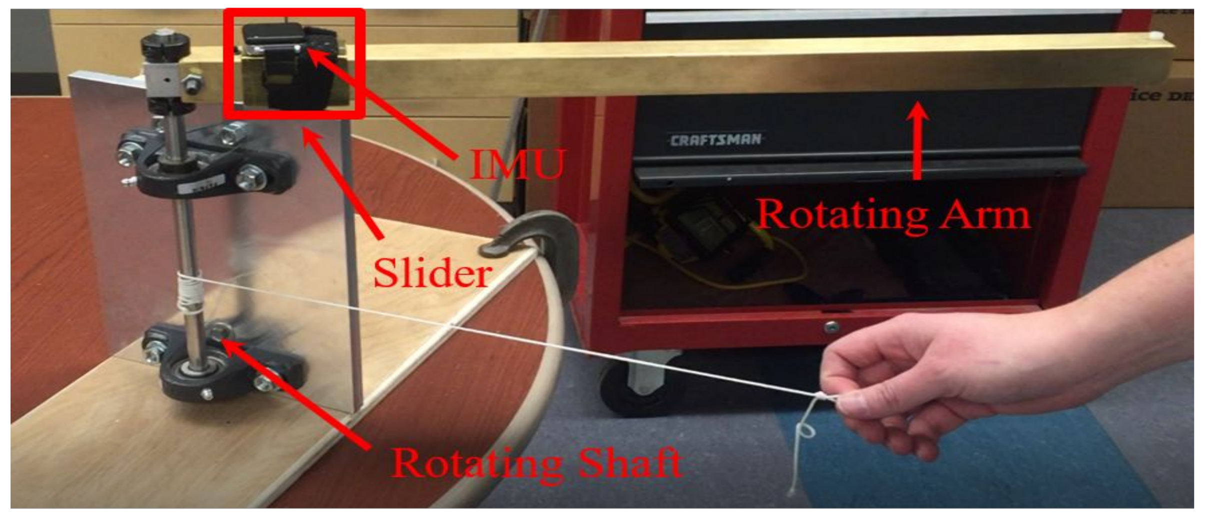

Figure 2: Demonstration #1 set-up of a rotating arm with a slider that demonstrates the Coriolis acceleration.

Tools for Evaluating Hypotheses

1) Dynamics Concept Inventory (DCI) [2]

2)-4) Longitudinal Assessment of Engineering Self-Efficacy (LAESE) [3]

Demonstrations and Prescribed Experiments

Designed demonstrations and prescribed experiments (Fig. 2, 3) around commonly misunderstood concepts as identified by the DCI.

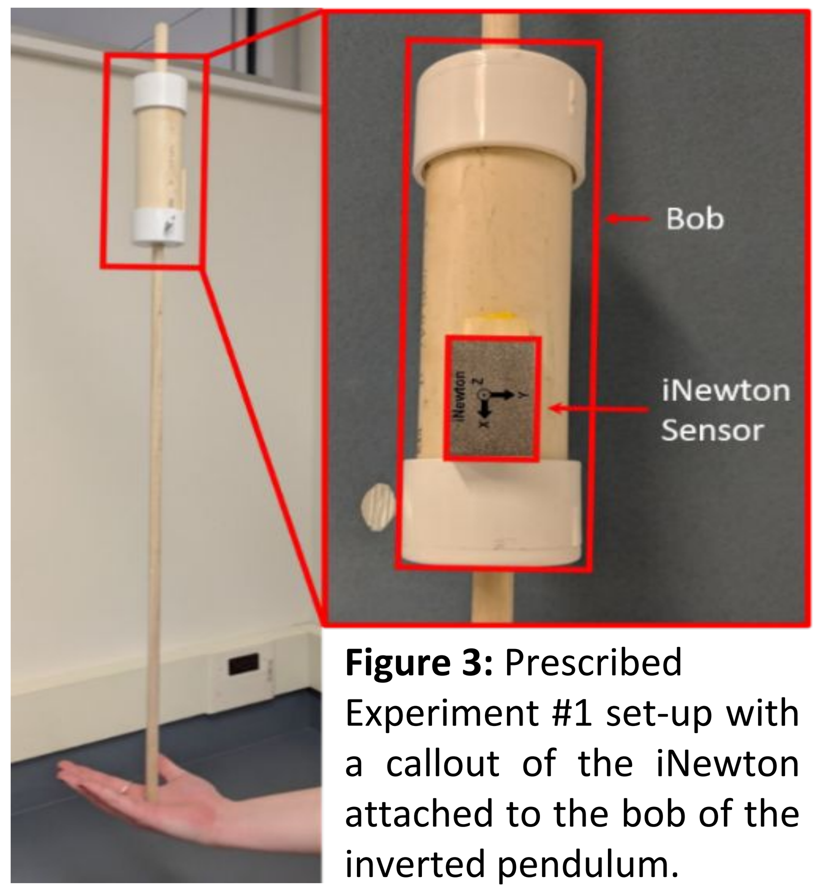

Figure 3: Prescribed Experiment #1 set-up with a callout of the iNewton attached to the bob of the inverted pendulum.

Conclusions and Future Work

Hypothesis 1) — DCI — Limited impact on improving understanding

Hypothesis 2) — ESE, CSE — Limited impact on improving self-efficacy

Hypothesis 3) — PER — Limited impact on intention to persist

Hypothesis 4) — INC — Limited impact on feelings of inclusion

No significant differences between demonstrations and prescribed experiments.
Student created project require more engagement, which will hypothetically improve results.

References

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