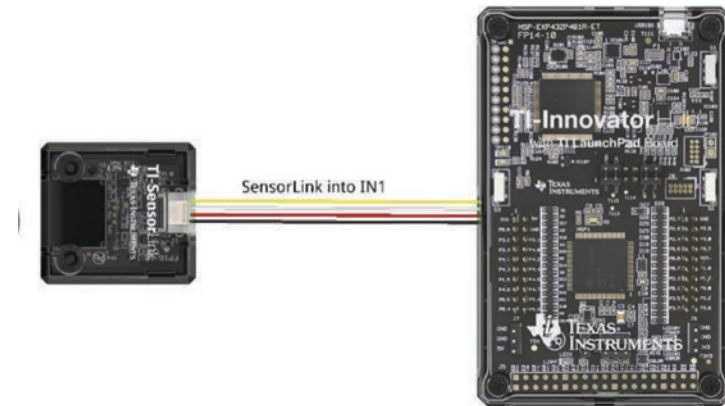




# TI-SensorLink

Use Vernier Sensors with TI-Innovator™ Hub



Karlheinz Haas - [haasconsulting@gmail.com](mailto:haasconsulting@gmail.com)

Stacy Thibodeaux - [svthibodeaux@gmail.com](mailto:svthibodeaux@gmail.com)

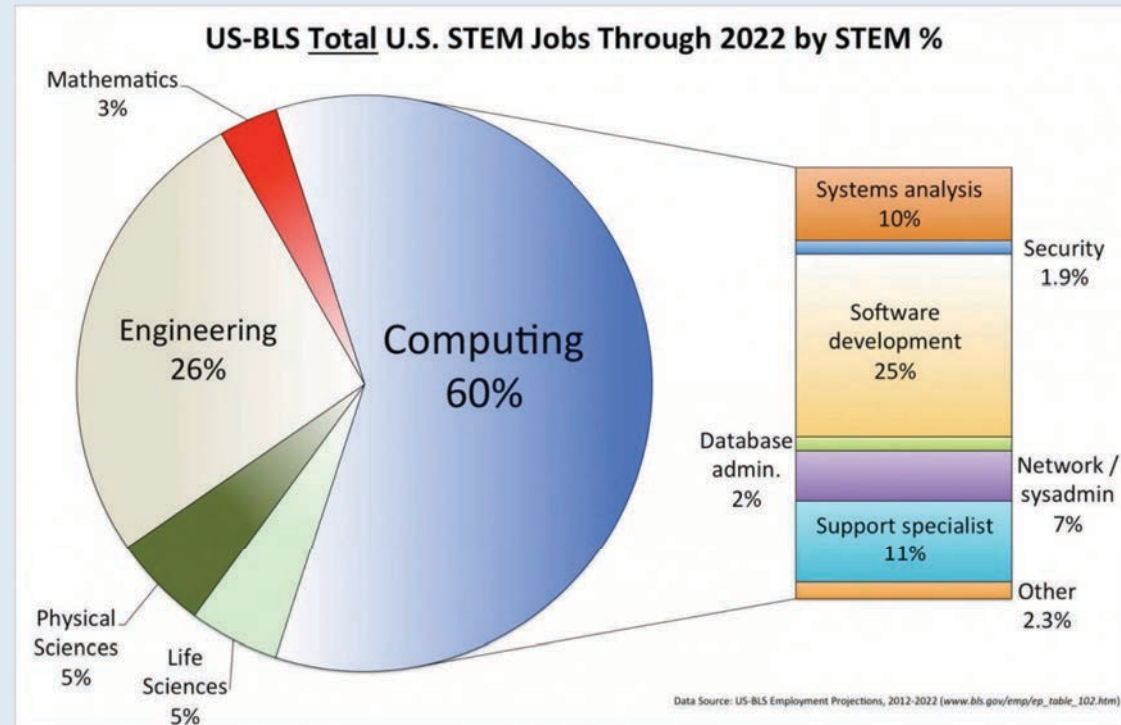
Twitter: @stacythib ----- @karl0294

Adapted from T<sup>3</sup> PD Day at T3IC 2019 with  
Cassie Whitecotton and Karlheinz Haas

# STEM Jobs by Area Through 2022

## Why STEM??

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<https://www.mistempartnership.com/about/why-stem-is-important.html>



# Data collection

TI Nspire CX/CAS/CX II and iPad app

84 Activity Central



# How do I get started?

*“We will always have STEM with us. Some things will drop out of the public eye and will go away, but there will always be science, engineering , and technology. And there will always, always be mathematics.*

— Katherine Johnson

[10 minutes of Code](#)

[TI Innovator Website](#)

[STEM Projects website](#)

# To find out more about TI-Innovator STEM Projects

**Email:** [STEM-Team@ti.com](mailto:STEM-Team@ti.com)

**See list of projects with links in PDF on Google Drive**

<http://bit.ly/STEMProjectLinks>

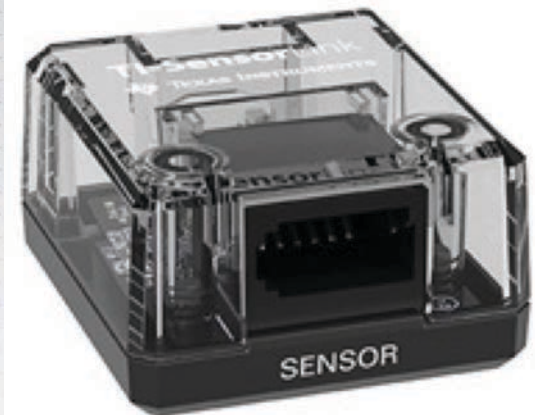
**Fill out Request Information form at**

<https://education.ti.com/en/resources/stem-projects>



# What is TI-SensorLink?

- Accessory to TI-Innovator Hub
- Expands STEM project possibilities with use of:
  - Stainless Steel Temperature Probe
  - pH Sensor
  - Dual Range Force Sensor
  - Gas Pressure Sensor



## **Note: This is not a data collection solution**

- USB connected probes to calculators or the TI Nspire Lab Cradle remain a superior solution for pure data collection and analysis

**If the “SensorLink is not a data  
collection solution”,  
THEN what does it do for you and  
your students?**

# Currently supported Vernier analog sensors

Stainless Steel Temperature Probe



Stainless Steel Temp

pH Sensor



pH

Send "CONNECT VERNIER 1 TO IN1 AS TEMPERATURE"  
Send "READ VERNIER 1"

Gas Pressure Sensor



Gas Pressure

Dual-Range Force Sensor



Force

TI officially supports these 4 sensors with  
TI-SensorLink (as of right now, anyway)



# Notes on TI-SensorLink

- Requires sketch v1.3 for TI-Innovator™ Hub
- Download and install TI-Innovator™ Hub Update Software
- Works with CE, CX and CX II platforms
- Sketch commands for TI-SensorLink are NOT yet in the Hub app (CE) or Program Editor menus (CX/CX II)
  - You can copy-paste the commands from the reference programs or samples from the Eguide below
- Eguide:  
[https://education.ti.com/html/webhelp/EG\\_Innovator/EN/content/eg\\_innovsys/m\\_sl-sensorlink/m\\_sl\\_what\\_is.HTML](https://education.ti.com/html/webhelp/EG_Innovator/EN/content/eg_innovsys/m_sl-sensorlink/m_sl_what_is.HTML)

# Stainless Steel Temperature Probe

## Some like it Tepid!

**Project Overview:** In this activity, students are challenged to design a system that informs the user if their coffee is too hot to drink. The system should notify the user of three states: Too hot to drink; too cold to drink; and just right to drink.

What onboard devices can we utilize on the TI-Innovator Hub to help with the task at hand?

# Coding the SensorLink

## Some like it Tepid!

```
Send "CONNECT VERNIER 1 TO IN1 AS TEMPERATURE"  
Send "READ VERNIER 1"  
Get t  
DispAt 3,"temperature is",round(t,1), "°C"  
(*VERNIER must be typed into the code)
```

Stainless Steel Temperature Probe



# Stainless Steel Temperature Probe

Fan – modify the provided program so that when the temperature exceeds a maximum value it turns on the servo motor, creating a fan.





## TI Nspire CX/CX II

Define temp3(=

Prgm

© This program uses the data from a Vernier Temp sensor to turn on a fan (servo motor)

Disp "-- TI-SensorLink + Temp sensor + Servo motor--"

Disp "(Press Esc to quit)"

Send "CONNECT VERNIER 1 TO IN 1 AS TEMPERATURE "

Send "CONNECT SERVO 1 TO OUT 3"

k:=getKey()

While k≠"esc"

    Send "READ VERNIER 1"

    Get t

    DispAt 4,"Temp: ",t

    If t>31

        Send "SET SERVO 1 CW 50 5"

    Then

        DispAt 5,"TOO HOT!"

    Else

        DispAt 5, "JUST RIGHT!"

    EndIf

    Wait 0.5

    k:=getKey()

    EndWhile

EndPrgm



## TI-84 Plus CE

```
Send("CONNECT VERNIER 1 to IN 1 AS TEMPERATURE")
Send("CONNECT SERVO 1 TO OUT 3")
Send ("READ VERNIER 1")
Get t
Disp "Temp",T
If T>31 Then
Send("SET SERVO 1 CW 50 5")
Disp "TOO HOT!"
Else
Disp "Just right!"
EndIf
Wait 0.5
End
```

# Gas Pressure

Gas pipeline pressure monitoring system – modify the provided program so that when the pressure drops to near atmospheric pressure an audible and visible alarm sounds.

Note: Record the value of atmospheric pressure for the room, this will be your threshold. Take into consideration a starting volume and pressure.





## TI Nspire CX/CX II

Define pressure()=

Prgm

Send "CONNECT VERNIER 1 TO IN1 AS PRESSURE"

key:=""

While key≠"esc"

Send "READ VERNIER 1"

Get p

DispAt 3,"pressure =",round(p,1),"kPa"

If  $p \leq 105$

Then

DispAt 4,"Pressure is too low"

Send "SET COLOR 255 0 0"

Send "SET SOUND 512 TIME 5"

EndIf

If  $p \geq 130$

Then

DispAt 4,"just right"

Send "SET COLOR 0 255 0"

Send "SET SOUND 256 TIME 5"

EndIf

key:=getKey()

Wait 1

EndWhile

Send "SET COLOR 0 0 0"

Send "SET SOUND 0 TIME 10"

EndPrgm

## TI-84 Plus CE

" Program for TI-SensorLink + Pressure

ClrHome

Disp "TI-SensorLink + Pressure sensor"

Disp " "

Disp "Connect Hub and SensorLink"

Pause "Press Enter to continue"

" Pressure sensor

Send("CONNECT VERNIER 1 TO  
IN 1 AS PRESSURE")

Repeat getKey

Send("READ VERNIER 1")

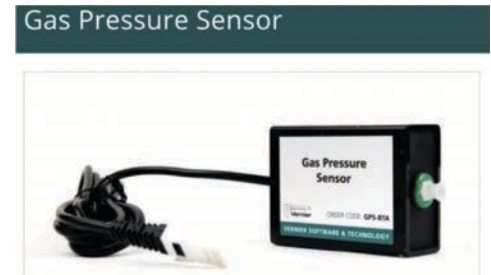
Get(P)

Disp "Pressure: ",P

Wait 1

End

Disp "Pressure test done"



# pH Sensor

Pool Alarm – modify the program for the pH sensor so that when the pH of swimming pool water is not within the range of 7.0 to 7.4, you get an audible and visible alarm.





## TI Nspire CX/CXII

```
Define pool_alarm()=
Prgm
Disp "-- TI-SensorLink + pH sensor --"
Disp "(Press Esc to quit)"
Send "CONNECT VERNIER 1 TO IN 1 AS pH"
setMode(1,16)
k:=getKey()
While k≠"esc"
Send "READ VERNIER 1"
Get pH
DispAt 3,"pH: ",pH
If pH<6.8 Then
  DispAt 4,"Pool water is acidic..."
  Send "SET COLOR 255 0 0"
  Send "SET SOUND 700 TIME 4"
  Wait 4
EndIf:
```

```
If pH>7.4 Then
DispAt 4,"Pool water is basic..."
  Send "SET COLOR 0 255 0"
  Send "SET SOUND 440
TIME 4"
  Wait 4
EndIf
If 6.8<pH<7.4 Then
DispAt 4,"Pool water is ideal pH"
Send "SET COLOR 0 100 100"
Wait 4
EndIf
EndWhile
k:=getKey()
EndPrgm
```

## TI-84 Plus CE

" Program for TI-SensorLink + pH

ClrHome

Disp "TI-SensorLink + pH sensor"

Disp " "

Disp "Connect Hub and SensorLink"

Pause "Press Enter to continue"

" pH sensor

Send("CONNECT VERNIER 1 TO IN 1 AS PH")

Repeat getKey

Send("READ VERNIER 1")

Get(P)

Disp "pH: ",P

If P<7

Then

Send("SET COLOR 255 0 0")

Else

Repeat getKey

Send("READ VERNIER 1")

Get(P)

Disp "pH: ",P

If P<7

Then

Send("SET COLOR 255 0 0")

Else

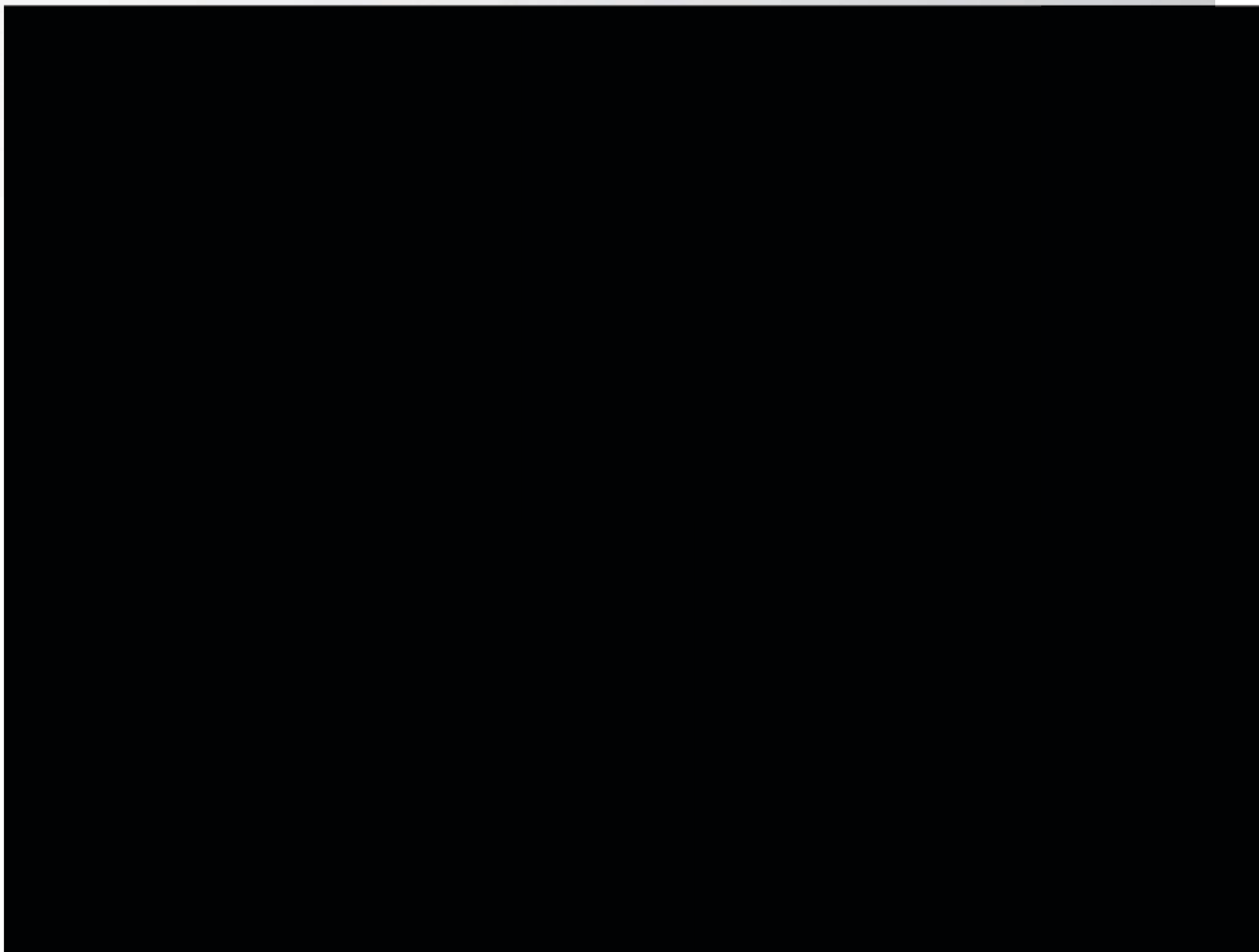
Send("SET COLOR 0 0 255")

End

Wait 1

End

Disp "pH test done"



# pH Sensor

Digital Litmus Paper – modify the program so that when a pH value is read by the sensor, the color of the Innovator Hub's RGB LED corresponds with litmus paper colors.



## TI Nspire CX/CXII

Define ph\_scale()=

Prgm

Disp "-- TI-SensorLink + pH sensor --"

Disp "(Press Esc to quit)"

Send "CONNECT VERNIER 1 TO IN 1 AS  
PH"

:setMode(1,16)

k:=getKey()

While k≠"esc"

Send "READ VERNIER 1"

Get ph

DispAt 3,"pH: ",ph

If  $0 < \text{ph} < 2.9$  Then

DispAt 4,"Acidic..."

Send "SET COLOR 255 0 0"

EndIf

If  $3 < \text{ph} < 4.9$  Then

DispAt 4,"Acidic..."

Send "SET COLOR 255 120 0"

EndIf

## TI Nspire CX/CXII cont'd

```
If 5<ph<6.9 Then
  DispAt 4,"Acidic..."
  Send "SET COLOR 155 85 0"
EndIf
If 7<ph<8.9 Then
  DispAt 4,"Neutral..."
  Send "SET COLOR 0 255 0"
EndIf
If 9<ph<10.9 Then
: DispAt 4,"Basic..."
  Send "SET COLOR 0 100 100"
EndIf
```

```
If 11<ph<12.9 Then
  DispAt 4,"Basic..."
  Send "SET COLOR 0 0 100"
EndIf
If 13<ph<14.9 Then
  DispAt 4,"Basic..."
  Send "SET COLOR 100 0 100"
EndIf
Wait 1.
k:=getKey()
EndWhile
EndPrgm
```



## Dual-Range Force Sensor

Modify the provided program so that the servo motor speed will increase with an increase in force.

## TI Nspire CX/CXII

```
Define sensorlink_force(=
Prgm
Disp "-- TI-SensorLink + Force Sensor --"
Disp "(Press Esc to quit)"
Text "Set sensor configuration to 10N"
setMode(1,16)
Send "CONNECT VERNIER 1 TO IN 1 AS
FORCE"
Send "CONNECT SERVO 1 TO OUT 3"
```

```
k:=getKey()
While k≠"esc"
Send "READ VERNIER 1"
Get f
DispAt 4,"Force: ",f
Wait 0.5
k:=getKey()
If f>2 Then
    Send "SET SERVO 1 TO CW 50"
EndIf
EndWhile
EndPrgm
```

## TI-84 Plus CE

```
" Program for TI-SensorLink + Force
ClrHome
Disp "TI-SensorLink + Force sensor"
Disp " "
Disp "Connect Hub and SensorLink"
Pause "Press Enter to continue"
" Force sensor
Pause "Set sensor to 10N"
Pause "Press Enter to continue"
Send("CONNECT VERNIER 1 TO IN 1
AS FORCE")
Repeat getKey
Send("READ VERNIER 1")
Get(F)
Disp "Force: ",F
Wait 1
End
```

```
Disp "Force 10N test done"
" Force sensor
Pause "Set sensor to 50N"
Pause "Press Enter to continue"
Send("CONNECT VERNIER 1 TO IN 1 AS
FORCE50")
Repeat getKey
Send("READ VERNIER 1")
Get(F)
Disp "Force: ",F
Wait 1
End
Disp "Force 50N test done"
```

# Supported Vernier analog sensors

Stainless Steel Temperature Probe



Stainless Steel Temp

pH Sensor



pH

Send "CONNECT VERNIER 1 TO IN1 AS TEMPERATURE"  
Send "READ VERNIER 1"

Gas Pressure Sensor



Gas Pressure

Dual-Range Force Sensor



Force

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