Conception and testing of modular robotic kits based on Poppy Ergo Jr for educational purposes

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Master thesis (2nd year) Human Computer Interfaces and Design (UPS, KTH)

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Context

This research in **Human Computer Interfaces** combines different fields such as robotics, computer sciences, cognitive sciences, ergonomics and design.

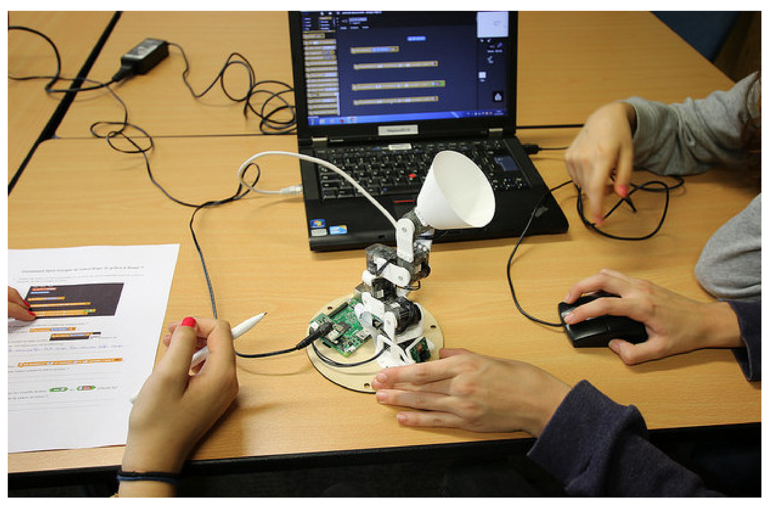
In partnership with 25 high schools in Nouvelle Aquitaine, the project is made to be flexible to the requirements of **ISN (Informatique et Sciences du Numérique)** or computer sciences courses and be a modular tool for teaching and learning basics of coding and robotics. It is made to be **simple** but also **customizable**. Users can find resources online and **share** their projects to the community.

So far several studies have been leaded about Poppy Ergo Jr : the usability of the robot [Desprez et al., 2018b], the impact on how people perceive robots with the Euro382 test [Eurobarometer, 2012] and comparison with another robot, the Thymio [not published yet].

Robotic Kit

- **User centred conception**

  [Noirpoudre et al., 2017] Since September 2015, regular meeting with users (teachers, students, robotic enthusiasts) have permitted to establish a collaborative design process and develop the robotic kit : **Poppy Ergo Jr**.



- **What is in the kit:**

  \- **Robot** : Ergo Jr is a robotic arm made of 6 motors (XL-320) running on a *Raspberry pi3*. The structure is made of 3D printed parts. All the ressources are avaliable oneline on the Poppy website *www.poppy-project.org* [Lapeyre, 2015].

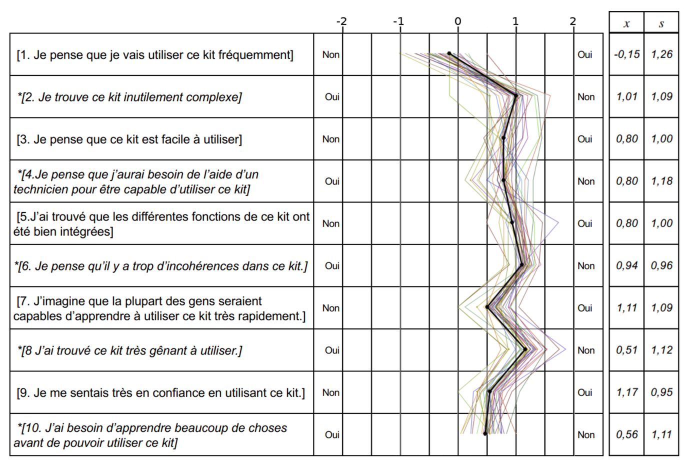
  \- **Code** : with *Snap!*, a visual "blocs" langage (*Scratch like*), with *Jupyter IPython Notebook*, an open-source web app for live coding, or any other language with the API-REST.

  \- **Guide and activities** : [Noirpoudre et al., 2016] For discovering basis of robotics and coding with activities applied to the robot. Discover the activities on *www.poppy-education.org*

Usability & Perception

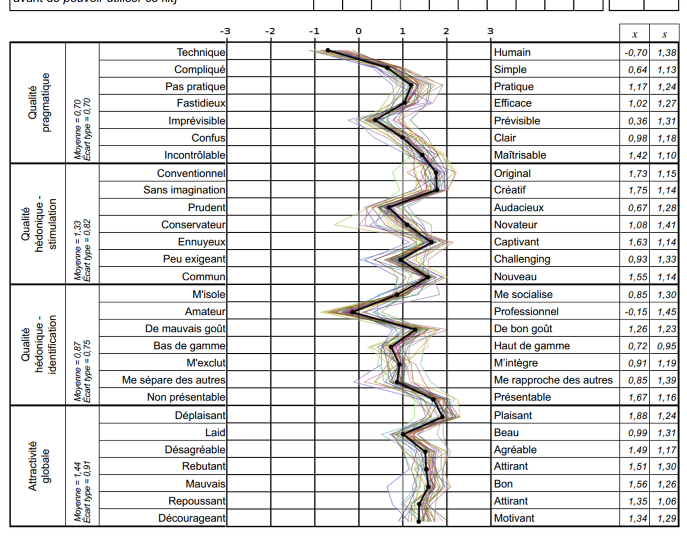
- **System Usability Scales**

  The SUS [Brooke, 1996] is a ten-item attitude Likert scale giving a global view of subjective assessments of usability. As defined by the ISO standard ISO 9241-11, a system usability can be measured by taking into account the context of use (who is using it, what they are using it for, what's the environment). It measures effectiveness, efficiency and satisfaction. [Brooke, 2013].



- **AttrakDiff survey**

  Created in 2003 [Hassenzahl et al., 2003] translated and validated in 2015 [Lallemand et al., 2015], is a questionnaire for overall UX evaluation using antonyms to test pragmatic qualities (usefulness, usability) and hedonic qualities (emotional needs, curiosity and identification). The resulting attractiveness is based on the combination of pragmatic and hedonic factors.



The results of June 2017 experiments ($N = 68$) are available in [Desprez et al., 2018b].

Protocole

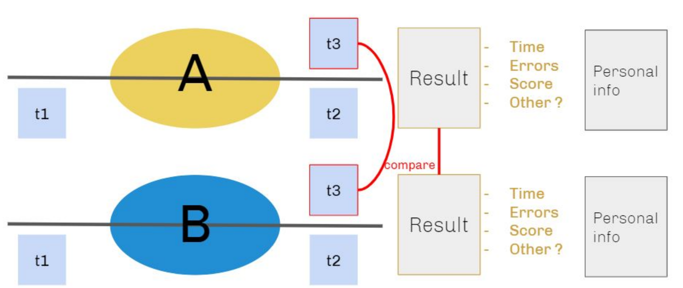
We will be evaluating how the activities are presented to the learner and the influence the task controlability [Viau and Louis, 1997] on motivation, choices and performances.

- **A - continuous activity**

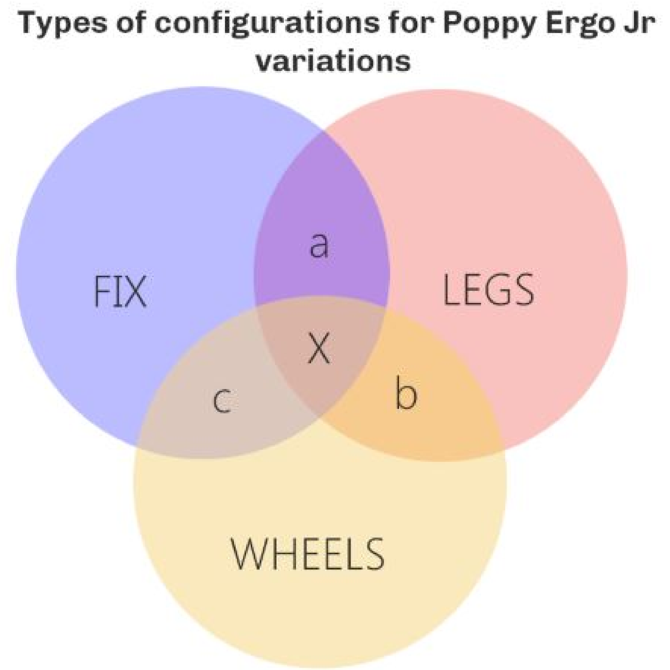
  The learner follow a given guide from top to bottom

- **B - separated tasks activity**

  The learner can pick the activity to start with



Conception of new robots



FIX	LEGS	WHEELS	OTHER
• Ergo Jr starter (4) + End Effectors (see below) • Ergo Jr (6) + End Effectors - Lamp - Grip - Pen holder - Ball launcher - U end - Labyrinth - Vader head - Captain head - Lynch head - Classic base - Simple base • Torso (different motors)	— Crawl — • Soft Starfish (6) • Snake mini (±8) — Walk — • Transform X (12) • Horse Robotica quattro (12) • Gipsy (12) • Multipod (9, 12, 18) • Diplo (12+6) • Humanoid (different motors)	• Poppy 4 wheels (4) • Dragster mini (2+4)	• Continuous track ? • Flying ? • Aqua ? • ???
Modify hardware structure (.stl files)	Modify hardware + software (motions functions)	Modify hardware + software (motors, motions functions)	Innovate

a	FIX + LEGS / ex : Diplo
b	LEGS + WHEELS / ex : ?
c	FIX + WHEELS / ex : Dragster mini
X	FIX + LEGS + WHEELS / FINAL BOSS (combine everything)

(n) number of motors XL-320

Having a classification of existing and potential new custom robots is a way to provide a map of possibilities to the users and guide them through different modalities for their design and ideation process. Based on some existing classifications of robots [Ben-Ari and Mondada, 2018], similarities could be developed for the case of variations of Poppy Ergo Jr. They are classified according the moving techniques of the robot but also according the number of motors. It is possible to make combinations of moving techniques to have a more elaborate robot.

How to build your robot ?

After choosing or creating a variation, the user can follow several steps to get a functional robot

- **Build a 3D file**

  It is possible to use 3D softwares or even online platforms to create 3D objects and save them in .stl files. And then printing these files with a 3D printer by going to a Digital Fabrication Lab (fablab).

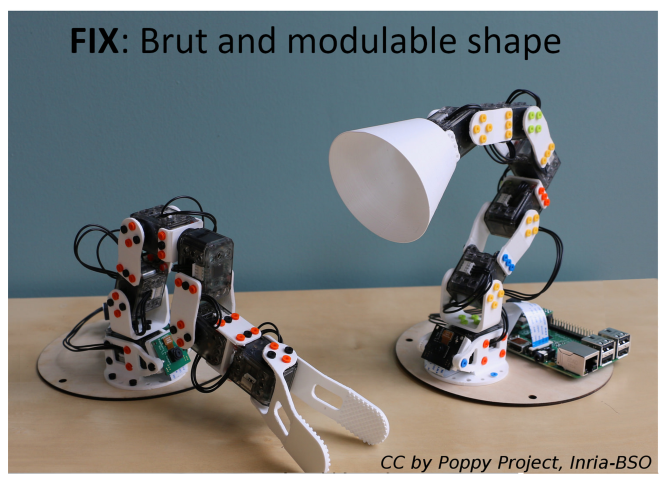
- **Assembling parts**

  A lot of pieces are included in the Poppy Ergo Jr kit (motors, screws, ...), they can be disassembled and reused on the new version of the robot.

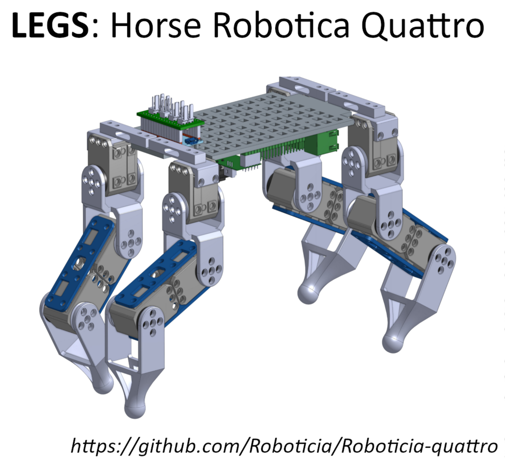
- **Adapting the code**

  The motions of the Poppy Ergo Jr are pre-set for a certain configuration of motors and their position. By adding or removing motors, re-arranging them or changing their functionalities, some parts of the code will need to be updated. (More at : *www.docs.poppy-project.org/en/getting-started/connect.html*)

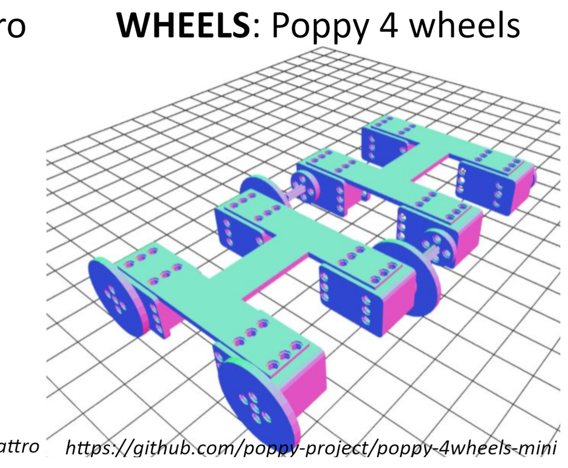
FIX: Brut and modulable shape



LEGS: Horse Robotica Quattro

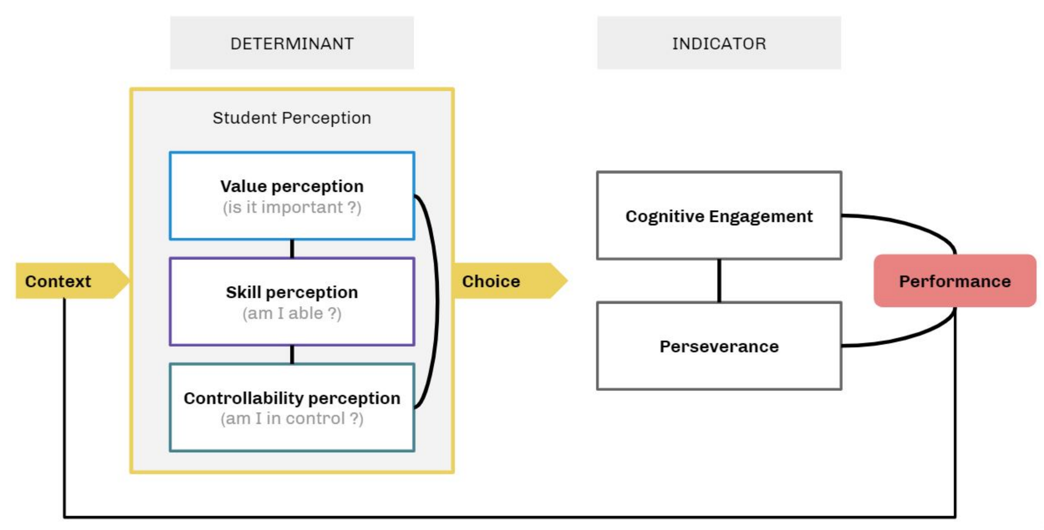


WHEELS: Poppy 4 wheels

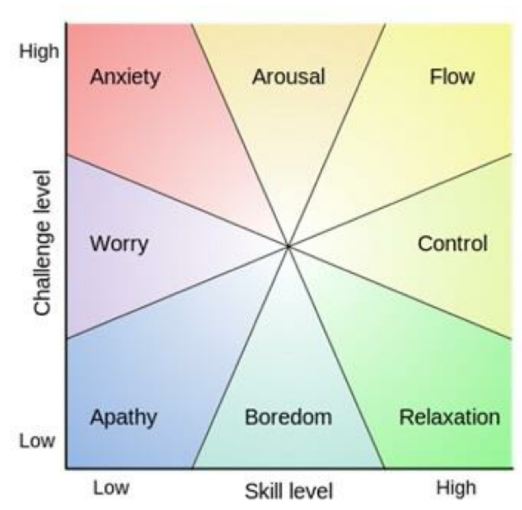


Motivation of the learner

- Viau Model of Motivation [Viau and Louis, 1997]



- Csikszentmihalyi's Flow Model [Nakamura and Csikszentmihalyi, 2014]



- **Tangible materials** are a key factor for the learner. The work of [Freinet, 1969], [Montessori, 2013] and [Alvarez, 2016] shows that having a specific object to manipulate focused on a defined task gives the learner autonomy, permits the learner to self correct errors and understand the abstract concepts behind.

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