



SCUDEM XI 2026

Problem A: Pediatric Prosthetics

A prosthetic limb can have a huge benefit for a child, allowing them to do more things they enjoy. A new limb can help a child gain more confidence and independence and help them interact with others and the world around them. An artificial limb requires maintenance and continual tuning, though. This is even more important for a child whose growth and changes occur much more rapidly compared to an adult.^[1]

Changing or replacing a prosthetic limb can require a great deal of resources especially in a remote area. Deciding when to replace a prosthetic limb is an important decision with respect to the health and well-being of a child. If the replacement or adjustments are expensive, though, the decision impacts a larger group of people due to financial stresses on the wider medical system.

An initial effort has begun to better understand when a prosthetic should be replaced or adjusted. You are asked to look at the direct physical impacts of a child's arm growth and the interaction with a prosthetic on the lower limb of the child's arm. In particular, the primary concern is the socket where the prosthetic is attached to the arm.

Design a set of simple actions for a child lifting an object. Your initial examination should only include motion in a plane. Then examine how the potential changes at the interface of the arm and prosthetic change as the child grows. The goal is to determine if there is a point at which there is a substantial change that should be given more detailed scrutiny. Your first model should be a simple examination of the basic mechanics. If possible, explore if there are further modifications that can be added to see if there are any potential concerns in other parts of the child's musculoskeletal system.

Bibliography

[1] Ghidini, Claudia et al. "Impact of Physical Growth and Development on Paediatric Lower-Limb Prosthetic Provision: Prosthetist Perspectives and Clinical Casefile Analysis From Cambodia." *Advances in rehabilitation science and practice* vol. 14 27536351251384354. 27 Oct. 2025, doi:10.1177/27536351251384354



Student Challenge Using Differential Equations Modeling

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Problem B: Group Dynamics In Foraging

The role of group interactions and foraging is a well known and well studied phenomena.^[1] A study of spider monkeys revealed that part of their cooperation includes proactive sharing of information. They also actively work to coordinate their activities. In particular the monkeys stay as far apart as they can and still remain in contact with one another.

As a way to gain insight into the role that the shared communication plays, develop a mathematical model for two animals coordinating their efforts to forage for food. Use your model to examine what happens for different levels of communication including how much detail they can share. Additionally, use your model to examine how important the accuracy of the information matters. For example, if the animal shares the wrong information or tries to deceive the other animal what impact does that have on the overall success for the animals.

Use your results to provide a report that can be used to help better understand what should be considered when trying to understand cooperative foraging. Which of the factors you consider are more important? Also, what is the relationship between the different factors? For example, does the distance between the animals matter more than accuracy or is there a balance between the two that must be kept?

Bibliography

[1] Ramos-Fernandez, G., Walker, R.S., Silk, M.J. *et al.* Uncovering complementary information sharing in spider monkey collective foraging using higher-order spatial networks. *npj Complex* **3**, 1 (2026). <https://doi.org/10.1038/s44260-025-00060-0>



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Problem C: Teacher Training In Nonverbal Communication

A vital aspect of any community is the education of its children. Teachers are expected to convey a great deal of information and do so with individuals who may not have the experience to share subtle cues or complex language. Careful attention to the use of nonverbal as well as verbal communication interactions between teachers and students can benefit the students.^[1]

The introduction of explicit training on non-verbal communications can impact students' early development. A question that arises is how an early intervention for teacher training can influence the long-term development of a student. Additionally, for what grade levels should the training be focused? Does training for later grades make the same impact or is there a grade level that benefits more than other grade levels from additional teacher training?

To gain some initial insights a school district wants to develop a model to approximate the impacts associated with non-verbal communication training for teachers. The model should indicate the level of impacts to a student over their whole education. The model will be used to approximate the impacts for teacher training at any combination of grade levels. An overview of the model's results should be provided including some estimate of the benefits for different scenarios compared to the costs associated with those scenarios.

Bibliography

[1] Bambaerero F, Shokrpour N. The impact of the teachers' non-verbal communication on success in teaching. J Adv Med Educ Prof. 2017 Apr;5(2):51-59. PMID: 28367460.