

Title	Development and evaluation of online approaches for improved kinaesthetic learning in science
Authors	Scanlan, Anna
Publication date	2022-06-17
Original Citation	Scanlan, A. M. (2022), 'Development and evaluation of online approaches for improved kinaesthetic learning in science', CoMH Learning and Teaching Showcase 2022, University College Cork, 17 June.
Type of publication	Conference item
Rights	© 2022, the Author.
Download date	2026-10-26 20:04:50
Item downloaded from	https://hdl.handle.net/10468/19414

DEVELOPMENT AND EVALUATION OF ONLINE APPROACHES FOR IMPROVED KINAESTHETIC LEARNING IN SCIENCE

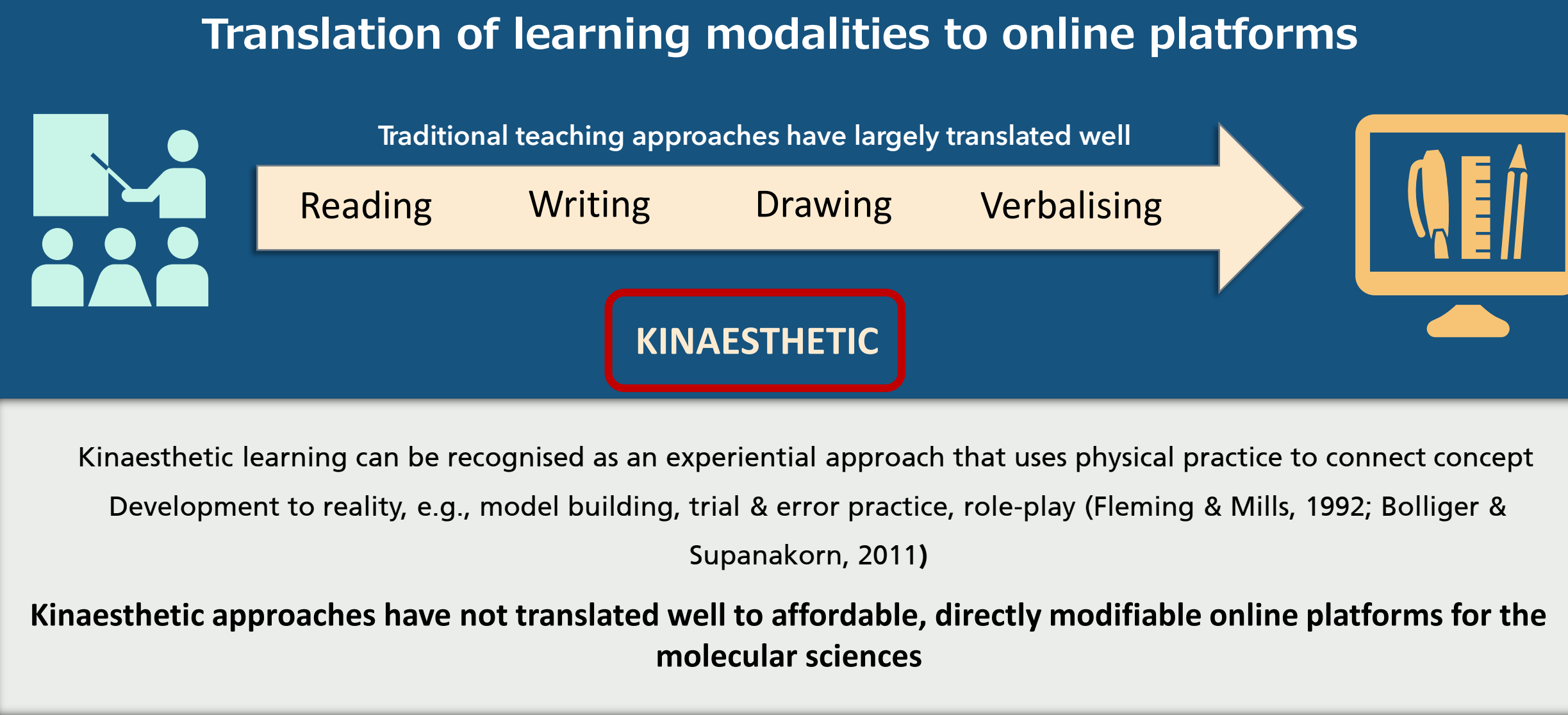
“For the things we have to learn before we can do them, we learn by doing them” — Aristotle

Hypothesis

Online kinaesthetic learning (KL) approaches would significantly enhance learning for students by helping them to grasp difficult science concepts faster through better visualisation and interaction with lesson content. In turn, this should lead to deeper understanding of the topic and enhanced long-term learning retention.

Information Processing

Information is transmitted along sensory axons from sensory organs toward the brain. The subsequent response in bodily movement is controlled by motor nerves running outwards from the brain. The evolutionary integration of physical & cognitive brain centres enables faster processing of information to facilitate ongoing learning while remaining adaptable to new environments. Active learning modalities activate more neural pathways. Hence, engagement of multiple regions of the brain by a task significantly increases learning (*Spatial Principle of Multisensory Integration*) (Lachs, L., 2022). Kinaesthetic learning (KL) approaches inherently activate more neural pathways through active learning versus passive learning through one sensory modality alone, e.g., reading or listening.



Motivation

Kinaesthetic techniques are routinely adopted in the physical world for learning tangible topics online as with the ‘Anatomage Table’ (Fig 1). Less clear is how to apply online KL approaches to intangible and invisible science content which is often presented in abstract format (Fig 3). Online kinaesthetic interactions are not being utilised effectively for learning in the molecular sciences. Current iterations of online kinaesthetic approaches are not available on affordable platforms or in formats that can be directly modified by the user. No framework exists to guide the translation of traditionally offline kinaesthetic approaches into an online format applicable to learning complex science.

Methodology

Ethical approval: Social Research Ethics Committee (SREC) UCC for mixed methods study amongst secondary school students (nationally), undergraduates (UCC) and postgraduates (UCC).

Experiments: 9 in total: 3 pilot studies & 6 two-timepoint studies, 2 of which were sub-studies

Assessment: Recall & transfer MCQs & SAQs in Google Form quizzes – results contained feedback

Lesson topics: DNA Transcription & Translation for secondary school students (>100 typically aged 15-19 yrs); the Lac Operon for 1st yr science & medicine undergraduate students (> 200); Salmonella virulence factors for postgraduates (n 18).

A KL assembly approach was integrated in formats into a science lesson in PowerPoint and delivered to students for independent remote use and all students remained anonymous throughout. Topics were chosen for which each cohort would have little to no prior exposure. Lesson material was condensed for learning in a single study session of ~ 30 min and followed immediately by a post-test quiz. A second quiz 7 days later measured long-term learning retention.

Results

Results show that KL assembly was at least as effective and in some instances better than, some top learning strategies identified in education psychology namely, computer notetaking (Chi & Wylie, 2014) and retrieval-practice (O'Day & Karpicke, 2021). All lessons facilitated self-directed, self-paced learning and enabled students to evaluate their own learning as they progressed by comparing completed task slides with expert version of the same slides. Thus, they are suitable as a formative assessment or feedback tool, complementary for use with summative assessments.

Conclusion

Online KL approaches based on an assembly model involving both movement and recall, are highly effective for long-term learning retention and for learning science material that is represented in a complex graphical and text format. Students with little to no prior science learning were able to complete an advanced science topic without the benefit of receiving months of background theoretical information usually required to scaffold understanding for the concepts, terminology and diagrams introduced. In addition, students were able to independently learn a lecture that is typically delivered in a 1 hr lecture in ~25 mins.

The development and evaluation of multiple approaches gave rise to the KLS framework, suitable for guiding the creation and incorporation of KL approaches into PowerPoint. This framework has proven to be scalable to incremental levels of knowledge, adaptable for direct modification by the user and accessible on the affordable PowerPoint platform.

Acknowledgements

I wish to thank my supervisors, Prof. Tommie McCarthy and Dr. Declan Kennedy for their guidance and support throughout this thesis research, it is hugely appreciated. I also wish to thank the School of Biochemistry & Cell Biology who funded the research, my colleagues in the iEd Hub for their feedback, and the committee of the NUI Dr Mary L. Thornton Prize in Education for their encouragement of this study which seeks not only to enhance science learning, but to simplify and share it through the use of digital technology.



Figure 2. ‘Anatomage Table’ (URL 1)

The collection of online KL approaches developed are referred to as the ‘Kinaesthetic Learning System’ (KLS)

Aim

Make complex, abstract topics easier to visualise & interact with, thus, faster & more intuitive to learn with less stress and more robust long-term recall

Objectives

Identify, design & develop novel approaches to facilitate online KL for molecular science

Challenge

Standard education research material typically uses <500 words to test approaches, using familiar language with familiar concepts, e.g., word lists, lightning formation.

Undergrad molecular biology requires scientific literacy to grasp intangible concepts.

Key parameters to evaluate any KL lessons

Test using realistic content, in a realistic setting on student's own devices

Test effectiveness of KL approach for those who may struggle with science

Test 1 hr lecture in < 30 mins to see if KL lesson can decrease time to learning

Test learning using exams that match difficulty level of content

References

- Bolliger, D. U., & Supanakorn, S. (2011). Learning styles and student perceptions of the use of interactive online tutorials [Article]. *British Journal of Educational Technology*, 42(3), 470-481. <https://doi.org/10.1111/j.1467-8535.2009.01037.x>
- Chi, M. T. H., & Wylie, R. (2014). The ICAP Framework: Linking Cognitive Engagement to Active Learning Outcomes. *Educational Psychologist*, 49(4), 219-243. <https://doi.org/10.1080/00461520.2014.965823>
- Fleming, N. D. a. M., C. (1992). Not Another Inventory, Rather a Catalyst for Reflection, To Improve the Academy, Vol. 11, 1992., page 137. 11.
- O'Day, G. M., & Karpicke, J. D. (2021). Comparing and combining retrieval practice and concept mapping. *Journal of Educational Psychology*, 113(5), 986-997. <https://doi.org/10.1037/edu0000486>
- Lachs, L. (2022). Multi-modal perception. In R. Biswas-Diener & E. Diener (Eds), Noba textbook series: *Psychology*. Champaign, IL: DEF publishers. Retrieved from <http://noba.to/cezw4qyn>
- URL 1: Anatomage Table. Sourced online from ‘Anatomage’ <https://www.anatomage.com/image-library/>
- URL 2: Nickle, T., & Barrette-Ng, I. (2022, April 9). The lac Operon. Mount Royal University & University of Calgary. <https://bio.libretexts.org/@go/page/4150>

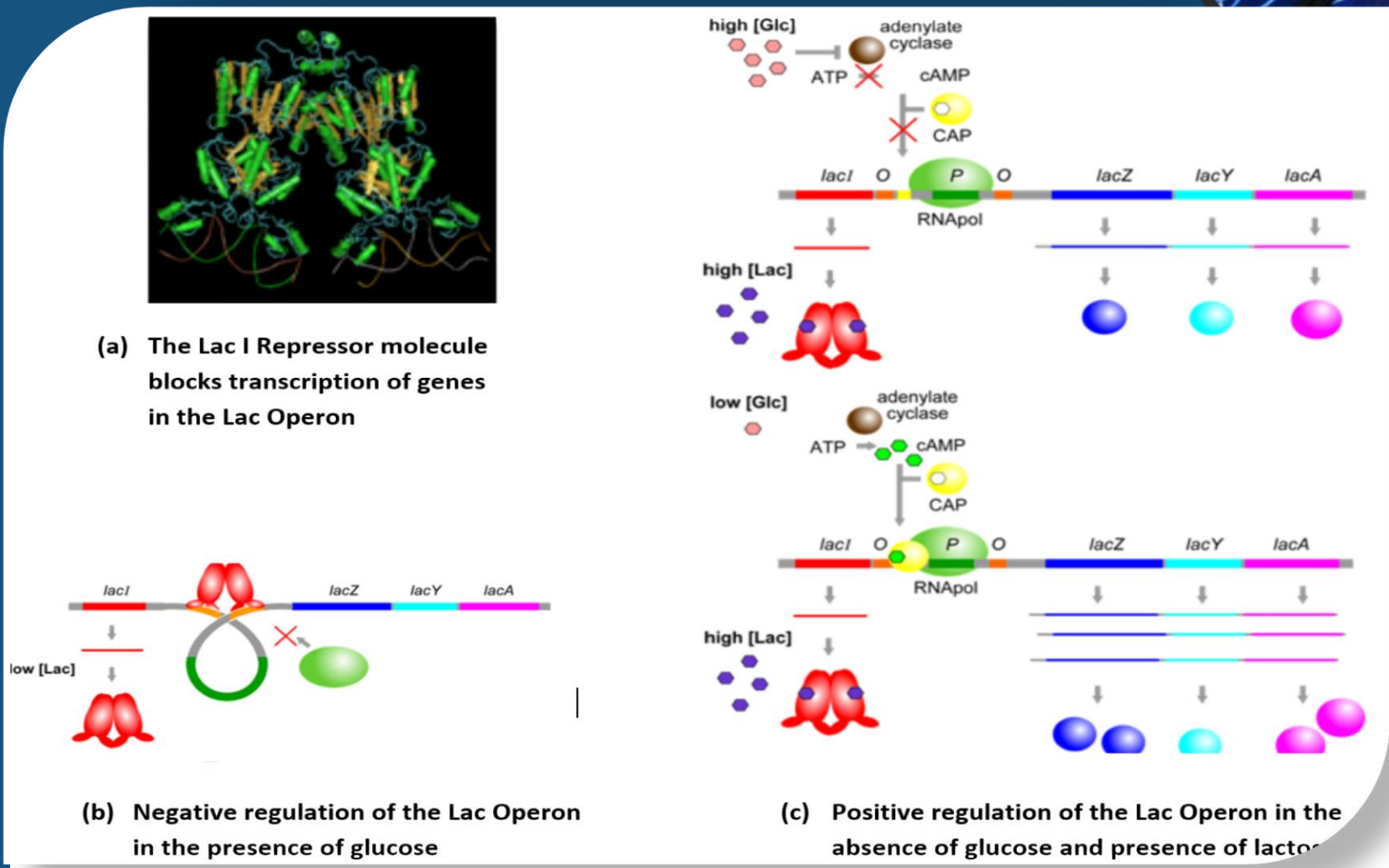
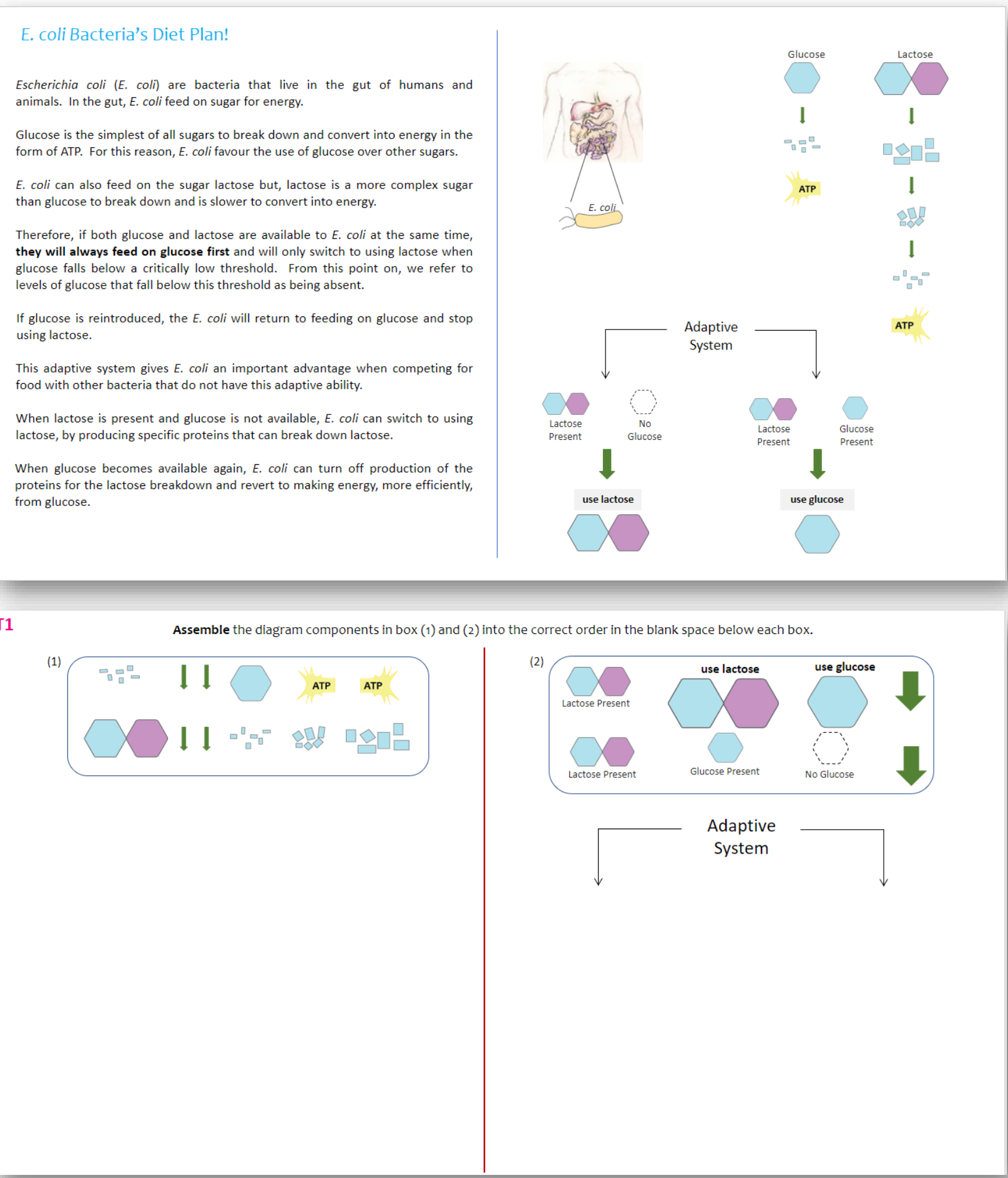


Figure 3. (a) & (c) ‘The Lac Operon’ (URL 2)

Lesson slide layout (9 in total) from the ‘Lac Operon’ PowerPoint given to undergraduates with matching task slide (7 in total)



Examples of a correctly assembled & poorly assembled tasks displaying corresponding grade outcomes

