

# Research Project for MA 4404: An evolving network of knowledge

## 1 Introduction:

Traditional education engages all students with the same topics, at the same time, and at the same speed. Such a system leaves some students behind and fails to challenge others. It also produces similarly skilled graduates, rather than enhancing the skills, experiences, and abilities that learners already have. An alternative would be to imagine a world in which professionals engage in lifelong learning complementing their formal education, while balancing personal and professional tasks because learning is personalized, adaptive, succinct and at their fingertips. This would be an adaptive & flexible learning environment that is learner-centric, where content is recommended to learners to meet their learning outcomes while building on each person's interests and existing skills. Additionally, unlike a traditional textbook whose content is static, this model needs to be supported by a network of knowledge that can grow in time as authors add new content to an existing repository of micro-lectures. Unlike most established sciences, new research fields such as Network Science hint at non-traditional methods of education that network the modules providing guided learning that can be influential on how we structure the future of learning.

The current project proposes to create a curated network of knowledge that incorporates network evolution to support dynamic growth as authors contribute new content or just as new content becomes available through other means (like newly collected data sets). As such, we seek to introduce a structure over a repository of micro-learning content (collection of short PDFs, videos, code, PPT, simulations, examples, exercises, etc) that allows for the new content to be incorporated and discoverable by learners or instructors. This network's function is to allow the creation of personalized and adaptive learning paths to enhance learner's education by filling in the exact missing gaps ('just in time' learning) while building on each learner's knowledge and experiences using adaptable targeted learning modules. This contrasts the linear, one-size-fits-all approach to traditional classroom and many current online approaches that includes all possible topics that may be covered in a traditional course catering to many students ('just in case' learning).

Much like a GPS navigation system dynamically adjusts a driving path from a source to a destination while roads are being built or closed, the structure or curation of the content allows a recommender system to assist the learner in moving through educational materials dynamically while the network evolves (some content may become obsolete, while new content and new concepts are being added, and these changes can take place daily). Based on each learner's background, a learning and development system would provide different choices in how to engage the learning content, while ensuring the learner reached the desired destination based on the competency needed by the learner (captured as individualized learning goals). Each student benefits differently from the available content as the suggested learning materials depend on learners' pre-existing knowledge, and allow the learner to dive deeper in topics, if desired. Simultaneously, the network of knowledge builds on the experiences of the students covertly guiding learners through the educational materials, much like Amazon.com [2] provides recommendations for buyers based on previous buyers' experiences. Likewise, GPS navigators can update routes real-time as other users experience traffic slow-downs due to accidents or rush-hour congestion.

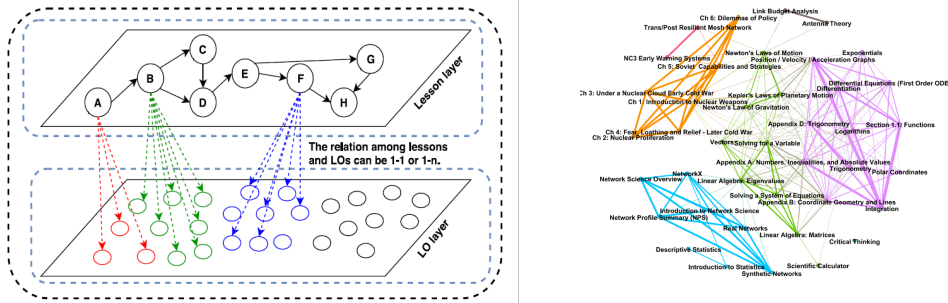


Figure 1: Two types of network (a 2-layered network of lessons and learning outcomes, and a content network [3, 1])

## 2 Task for each team:

The project is broken down into two components: In MA 4027 we created a synthesis of existing work that can influence the direction your group can take for the creation of a Dynamic network of knowledge. This becomes the Chapter 2 of a research paper that you currently work on. In MA 4404 we now create a paper that builds on that lit review, and introduce the methodology for the network of knowledge either as an extension of one or more models discovered in the literature review, or as a brand new model (it may be infused by ideas from other models). This methodology can then either be applied to data, or by creating an algorithm that produces such network as a synthetic model that:

- can be created at different scales of networks (like a network of 100 nodes, or 1000 nodes)
- accounts for the dynamic nature of the network as modules are added or retired
- may bring a focus on mutli-dimensional and/or multilayer networks.

The resultant network of knowledge will include a collection of educational modules tagged with learning outcomes that could become their own separate layer, and may include authors, learners, tags and so on as desired (see Figure 1). The navigation could be through the content or through the learning outcomes, as long as it supports 21st century learners who have access to information any time, from anywhere, either as directed learners or self-guided/exploratory learners. Each directed learner's view may have a different number of nodes and edges depending on the pre-identified needs (such as from a pre-assessment or a transcript review), and needed competencies (learning outcomes chosen). To support the self-guided lifelong learners, the model should account for network growth either from students' demand for future topics or instructor's additional content. The dynamic network of knowledge should adjust to feedback from instructors and other learners. Learners should be able to influence the network by providing feedback and guidance to other learners based on their experiences. This guidance will come as suggestions highlighting materials, methods, or styles that supported or impeded their success. The desired model should have the capability of conducting covert assessments in order to use machine learning algorithms to improve the model, while doing so transparently to the learners.

Exploit existing methodologies and introduce innovative approaches to link the network's modules. Think outside the box, take a chance and try an out of the ordinary model! "The significant problems we face cannot be solved at the same level of thinking we were when we created them."— Albert Einstein.

## References

- [1] Raluca Gera, D'Marie Bartolf, Simona Tick, and Akрати Saxena. Chunk learning: A tool that supports personalized education. In *Proceedings of the 15th International Conference on Educational Data Mining*, page 743, 2022.
- [2] Greg Linden, Brent Smith, and Jeremy York. Amazon. com recommendations: Item-to-item collaborative filtering. *IEEE Internet computing*, (1):76–80, 2003.
- [3] Amir Hossein Nabizadeh, Daniel Goncalves, Sandra Gama, Joaquim Jorge, and Hamed N Rafsanjani. Adaptive learning path recommender approach using auxiliary learning objects. *Computers & Education*, 147:103777, 2020.