Interactive Tree Map For Visualising Transnational Engineering Curricula

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***Abstract*— In response to issues in engineering education, where academic staff do not have an overview of how their courses fit into the curriculum as a whole (or what students' prior knowledge is), we have designed an interactive tree map that allows staff and students to visualize their curricula. We have invited a total of 438 third year students to evaluate the effectiveness of this tool. According to surveys that were completed by 60 students, 70% of students rated their experience as positive, with 22% indicating that the visualization tool was generally excellent. Moreover, 30% of students indicated that the interactive tree curriculum map was excellent for understanding the curriculum structure. Due to the challenges of block teaching in transnational programmes, these interactive tree maps are therefore a useful visualization tool to help students better understand course progression and curriculum development.**

Keywords—Curriculum Mapping, Visualization, Engineering Education.

I. INTRODUCTION

Curriculum maps can play an important role in teaching, quality and curriculum management [1]. They can be used to plan student learning, as well as effective assessments that are aligned with course aims and learning outcomes [2]. The majority of curriculum maps used in the literature are static, or are represented in tabular form. Instead, we have developed a web-based interactive curriculum map, which is based on the network modelling approach presented in [3]. There have been several visualization techniques developed in the literature including radial visualization [4] and concept mapping [5]. These maps have been used in undergraduate teaching of non-engineering disciplines such as medicine [6].

A curriculum map includes what students are intended to learn, in what sequence, as well as the relationships between them. Moreover, major learning outcomes can be neatly connected in these maps, as previously demonstrated in a project led by MIT to map an undergraduate curriculum in the Department of Aeronautics and Astronautics [7]. Clearly displaying this information can therefore facilitate a deeper understanding of curriculum progressions and can be used as a tool for curriculum review and curriculum development [8].

The literature indicates that students can learn better using a dual modality of text and graphics [9-11]. Consequently, we have embarked on a project that aims to develop an interactive tree map of a transnational engineering programme, which combines both text and graphics to make it easier for students to understand curriculum structure and progression.

In Section 2 of the manuscript we describe how we have compiled the data to develop our interactive curriculum map, as well as the survey used to collect student feedback. Moreover, results from our surveys are described and discussed in Section 3. Finally, concluding remarks are presented in Section 4 of the manuscript.

II. METHODS

An interactive curriculum map was developed for the Glasgow College-University of Electronic Science and Technology of China (GC-UESTC) Electronic and Electrical Engineering (EEE) programme. As previously mentioned, this map was based on the approach described in [3] and uses Java script. Connections between courses were constructed by reviewing the specifications sheet of each course and understanding what pre-requisites were required by each course. Subsequently, the map shown in Figure 1 was developed and reviewed by staff during a monthly meeting to obtain their feedback regarding its correctness and validity for our programme. Snapshots from the programme are shown in Figure 2. Hovering over the courses with a mouse results in connections between courses to be made.

To obtain student feedback, an open online survey was designed and administered to students. Our approach to survey design and development is described in the following Sections.

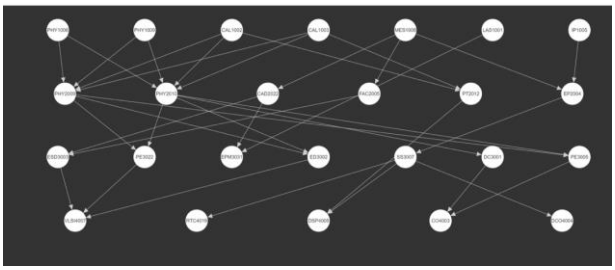


Figure 1. Snapshot of the Glasgow College-UESTC EEE with Information Engineering programme.

A. Participants

We chose to carry out our investigations with third year students from two different courses within the Electronic Engineering programme. The first course is in Power Electronics (PE), while the second is in

Engineering Project Management & Finance (EPMF). We chose these two courses since their learning outcomes are entirely different. In total, there were 232 students registered in the PE course, and 206 students in EPMF. A total of 438 students were invited to take part in our project. Moreover, a total of 60 students took part in our surveys. Therefore, a response rate of approximately 14% was achieved. According to the literature [12], this is considered an acceptable response rate for a class size of 500 and a confidence level of 80% and a sampling error of 10%.

B. *Procedures*

The activity involved asking students to view a 1-minute video demonstrating how the interactive curriculum map works. The video was appended to the open online survey, which was administered in week 16 of the second semester. Our objective was to understand how students found the interactive tool useful, rather than to agree to its correctness. Participant consent was obtained prior to undertaking this study. Students volunteered on an individual basis and indicated their agreement to participate in the study via a consent form. They were informed that their participation is completely voluntary and that all collected information will be anonymous and confidential.

C. *Questionnaire Design*

Our survey consisted of 3 main questions. The first question aimed to understand from students how often it was necessary to update the curriculum map. Students were given six answer options, which were "Weekly", "Monthly", "Every Semester", "Every Academic Year", "Every Calendar Year" and "Whenever Necessary".

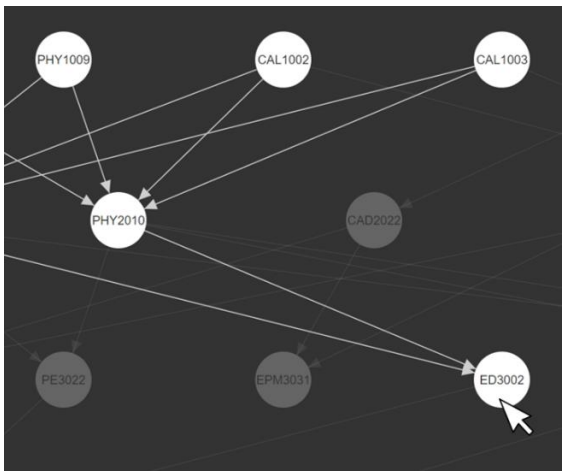
The second question asked students how they preferred visualising the curriculum. Currently, our curriculum map was divided into four academic years. To understand student preferences, participants were given four answer choices, which were "four academic year levels", "five calendar year levels", "eight semester levels" and "any other method".

The third question asked students to rate their experience in using our visualisation tool via a 5-point Likert scale ranging from 1 (poor) to 5 (excellent). Students were asked to rate their experience in "General", in "Selecting their degree programme", in "Curriculum review and development", in "Assessment preparation", in "Understanding curriculum structure", in "Curriculum progression", in "Understanding links between different disciplines", in "Course selection", in "Understanding links between courses" and in "Selecting elective courses".

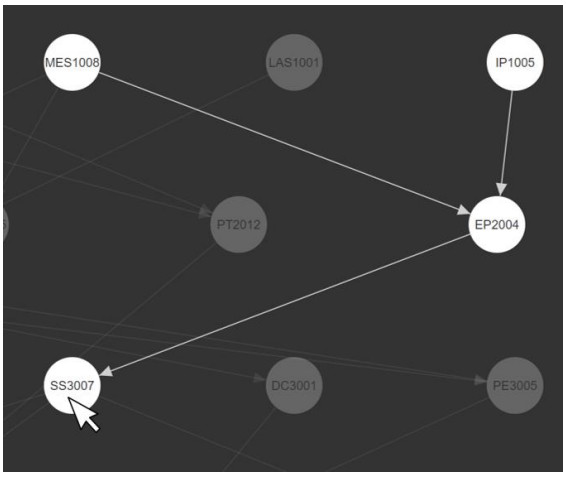
III. Results & Discussions

Results from the surveys that were completed by 60 students enrolled in two different third year courses i.e. PE and EPMF are demonstrated in figures 3 to 5. According to our results, 67% of students agreed that the interactive visualisation tool is useful for selecting elective courses in their fourth year of study. Moreover, 25% strongly agreed that the tool is useful for course selection. Thankfully, 70% of students believed that the tool helped them understand the overall curriculum structure. Approximately 10% of student's felt that the tool was impractical in selecting their desired degree programme. Perhaps this is due to our participants being third year students, who have already chosen their degree discipline. Consequently, we intend to extend this work by obtaining student feedback from a wider range of first and second year students. Generally, 70% of students agreed that the tree mapping method was a useful means for curriculum visualisation.

Similarly, when students were asked how often the tree map should be updated, the vast majority (32%) expressed that it should be updated on a monthly basis, as shown from the results in figure 4. Perhaps this is to ensure that all new courses proposed by a large faculty member body are captured in a timely manner.



(a)



(b)

Figure 2. Hovering the mouse cursor over a course results in connections to be highlighted, as demonstrated in (a) and (b).

Finally, 52% of respondents preferred an eight-semester map for visualising their curriculum, in comparing to other methods. Consequently, an area for further improvement involves developing an updated tree map divided into eight semesters, rather than four

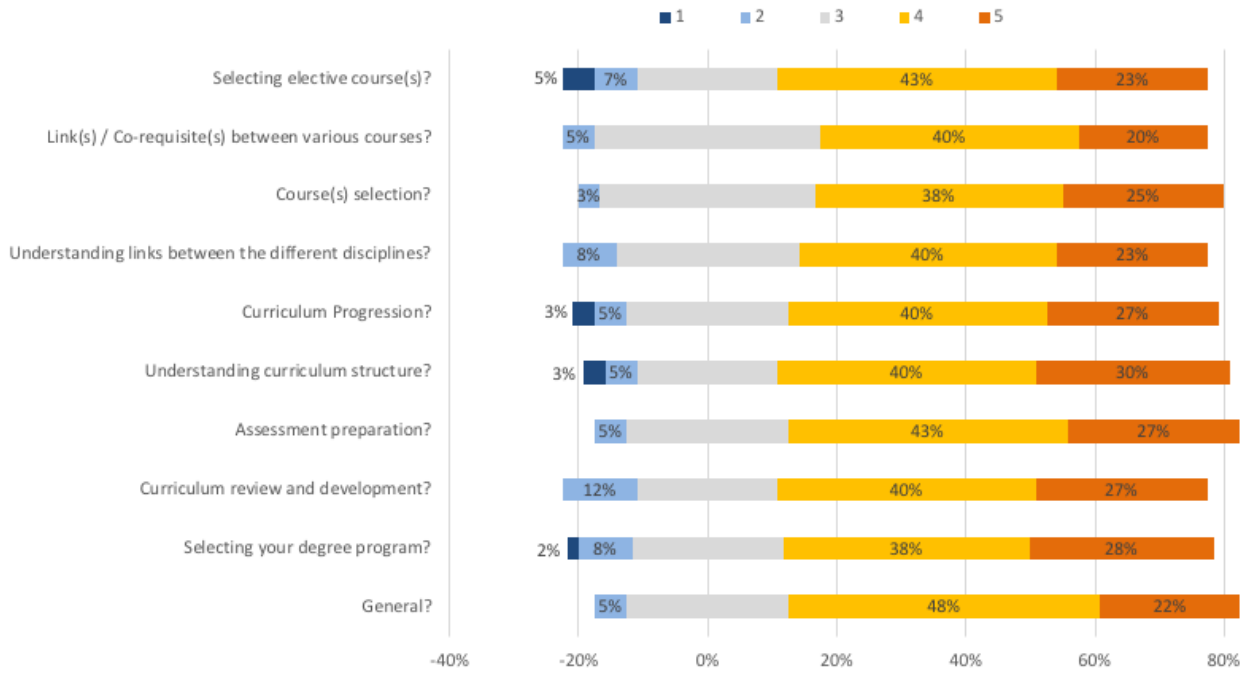


Figure 3. Student responses to "On a scale of 1 (Poor) to 5 (Excellent), how would you rate your experience with the visualisation tool in terms of its usefulness in: […]?"

academic years, which demonstrates links between courses.

Despite the positive responses, there are limitations to our investigations. It is noteworthy to mention that our surveys were completed by third year students only. Moreover, 60 students from PE and EPMF courses responded to the surveys, but it is not known what proportion of students from these two courses participated in our project. It was also not possible to determine how each group of students from these two courses responded to the surveys, and what were the major differences in their choices. For example, the mathematical or technical nature of the PE course may have influenced how students taking this course interacted with the tool.

Consequently, to extend our investigations, we plan on testing this interactive curriculum map with students across more levels of study. Furthermore, we plan on including demographic questions in our future surveys to better appreciate the background of our participating students. We also aim to gather open-ended responses from students to understand why some of them had a negative experience with the curriculum mapping tool.

Another limitation is that our course mapping was based on our understanding of each course's requirements and pre-requisites. Moreover, compiling the curriculum map has been a centralised operation. We plan on giving staff greater flexibility, such that they can add new courses and make their own course connections. Instead of the yearly division, we also plan on comparing other course organisation structures with our students.

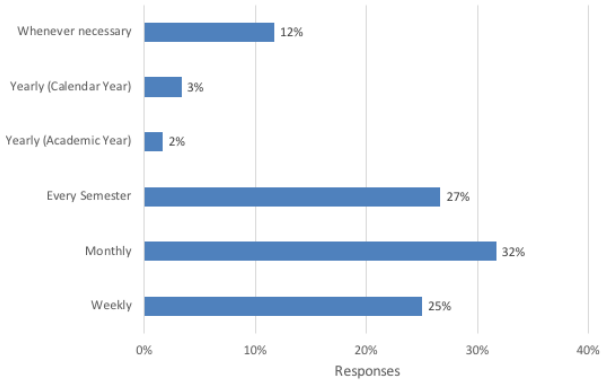


Figure 4. Student responses to: "How often do you think the tool should be updated?".

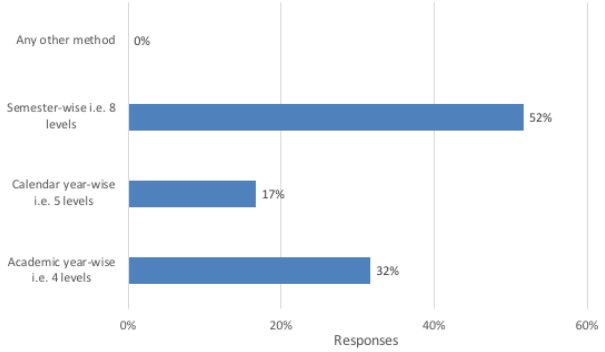


Figure 5. Student responses to: "In terms of hierarchical levels, how would you prefer to visualise the curriculum?"

IV. CONCLUSIONS

Visualising curriculum was echoed to be important and useful by the GC-UESTC 3rd year undergraduate students that participated in this study. More importantly, the interactive tree map utilised as a tool for visualising curriculum attracted high attention from the participants, especially in terms of progressing with respective courses within the EEE programme. Specifically, students' opinions were gathered around the tools structure, update frequency, and its usefulness and effectiveness. Based on the demonstrated results, we conclude 52% preferred to have the structure displayed with respect to each semester, 32% preferred the interactive curricula map to be updated on a monthly basis, and all the attributes around the tools usefulness and effectiveness were ranked highly by a range of 60-70% respondents. Hence, this proves to be a very useful tool for students and motivates us to investigate further.

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