Prototype design for a skill and competence development platform utilising Artificial Intelligence

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Laurea University of Applied Sciences

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Laurea University of Applied Sciences **Abstract**

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The purpose of this thesis project was to develop a learning platform prototype and explore how to build the platform into a unique tool that does not yet exist in the educational field. This thesis project was completed for Laurea University of Applied Sciences and their collaborations with Headai Oy on Artificial Intelligence projects.

Tasks began with a few scenarios of a user interacting with a potential platform. Preliminary prototyping and further research have developed into a working prototype utilising the ReactJS framework and various libraries to expand functionalities. The platform would utilise skill and competence based Artificial Intelligence solutions provided by Headai. Research frameworks include Web design, Software engineering and Data visualisation. The prototype is to be deployed onto a cloud platform for testing, feedback and further development.

The outcome of this project is an Extreme prototype that has been deployed and deemed mature enough by the client and supervisor of the prototyping phases, Asko Mononen (Senior Lecturer, Laurea University of Applied Sciences). The client wishes to explore funding options and to pitch the platform to additional external shareholders, to further develop the platform and finally the final stage, implementation of the platform.

Keywords: ReactJS, Data visualisation, Front-end Development

Contents

1 Introduction

This project's main stakeholder is Laurea University of Applied Sciences, whom are continually developing new Artificial Intelligence projects in collaboration with 3AMK (Haaga-Helia, Laurea and Metropolia) and Headai Oy.

The purpose is to design a learning platform to utilise Artificial Intelligence via API calls. Teachers would be able to easily create, edit and publish learning materials, students would just as easily be able to boost their competencies with the provided learning materials.

A few steps were outlined in the initial stages of the ideation of this project, from there research was to be conducted and begin to design wireframes. Once the wireframes of logical steps of user interaction with the platform were designed, feedback was given and relevant adjustments made. Once the client had approved the initial ideas, prototyping stages began and further research into Front-end development frameworks and libraries to create the user interface and how best to display learning materials and feedback via Data visualisation.

A prototype is to be delivered for the stakeholders via a cloud service.

1.1 Stakeholders

3AMK is composed of three Helsinki Metropolitan area Universities of Applied Science, whom have been collaborating with Headai Oy on new innovative services to provide to their students.

Headai Oy provide multiple award-winning Artificial Intelligence solutions to futureproof businesses. Their core technology is based around Cognitive Text Analytics and how these solutions can be logically displayed. Headai collectively have over 20 years of expertise in learning sciences and Artificial Intelligence. A very noteworthy solution is the TextToKeywords Reference tool, the Artificial Intelligence is able to detect skills and competences from a provided document. Training the Artificial Intelligence has been as extensive as reading and processing 14 million job advertisements (Headai 2022a).

In 2021, the author had the opportunity to work in a collaboration project with Headai and has been able to familiarise with their technologies, hence this project will be utilising inspiration from their solutions.

1.2 Objectives

Perleto (Personalised Learning Tool) is a proposed web application with the given requirements from the client. The author is to understand Software and Web design principles in detail, understand effective usage of Data visualisation and how the Artificial Intelligence could be best utilised on the platform. Once specific requirements have been understood, the author is to begin planning and designing a potential solution for the presented tasks and propose an appropriate approach to building a prototype (whether it be done in JavaScript or Wordpress for example). Once the prototype has been approved by the client, the prototype must be available online via a cloud deployment service within the initial timeframe (by the end of year, 2022).

2 Design principles

2.1 Web design principles

Faller (2020) suggests that Front-end design connects two worlds, User Interface tools and development of business logic. Front-end developers must turn ideas and designs into real products that users can interact with that provides a “good user experience”. There are many factors that can play in the user’s experience.

First impressions can be very important, Mishunov (2015) reveals quite a shocking factor, that it can take only 3 seconds for a user to abandon a website. Mishunov continues by stating that AutoAnything (Vehicle parts retailer) were able to increase their sales by 13% by reducing the loading time of their service by half. A web page must load between 0.5 and 1 second for the user to be engaged optimally, as psychological research has uncovered that average attention spans are only between 5 – 10 seconds. Nielsen (2011) confirms this, as “you must clearly communicate your value proposition within 10 seconds”. Performance issues can be down to many things, interestingly, Netflix had -50% reduction in Time-to-interactivity by simply removing ReactJS and corresponding libraries (Faller 2020). Overall satisfaction can be boosted by positive first impressions. Complex, busy or boring designs, lack of navigation, too many pop-up adverts and use of colour can detriment the user’s experience, as 94% of first impressions are design related, rather than content (Laja 2019). As our brains process information from visuals 60,000 times faster than text, this suggests that colours and images are initially more important than purely textual content (McCoy 2019).

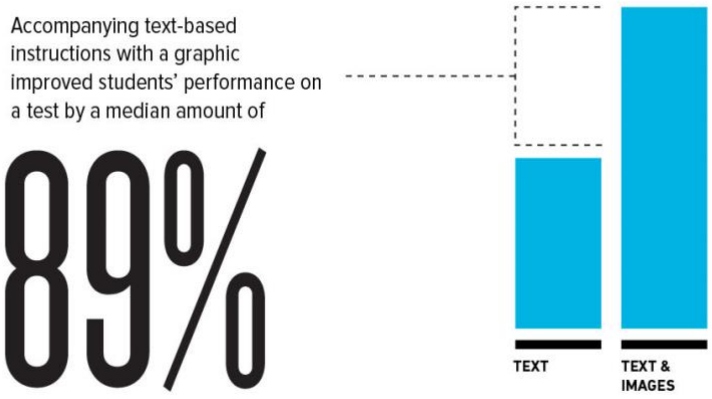

Figure 1: Text images improve comprehension (McCoy 2021)

Colour psychology can play a huge role in how we perceive and respond, so naturally a brand's image, message and uniformity are something that need to be considered to provide a lasting first impression. Red can correspond feelings of danger, yet also romance or passion whilst blue, can represent intelligence, calming and trust (Colorpsychology.org 2021).

Friedman (2021) suggests that "users don't read, they scan" which would back up the impatience detailed above. Having a statement which sums up the purpose of the user being somewhere would be most logical, a simple slogan or phrase. Friedman continues that "all components should be designed so their meaning is not ambiguous", from this I would see it to be important to explain briefly what the user should expect from visiting. Space is also important, so the user can scan the text quickly and comfortably.

Additionally, Friedman states that users tend to read in an F-pattern. Designs must be so comprehensible, that they are left with "as close to 0 question marks" about the purpose of the page. Choice of font can also be important, that it is not wise to use more than 3 types of fonts and to keep the text sections rather brief. This becomes especially relevant, when considering the KIS principle (Keep It Simple), so the user can be successfully engaged and swiftly.

Figure 2: Eye tracking Heatmaps (Line 2019)

Blending User Experience and User Interface logic, studies have been conducted and shown that effective web design should apply this logic to drive user engagement in a natural manner. By using eye tracking and heatmapping the results, it is quite clear how differently information is visually processed through different design approaches. In these heatmaps, the grey areas attracted little or no attention, blue attracted somewhat, the red areas attracted the most attention. Referring to the heatmap's results on the right, it is quite clear that Google's search bar and navigation attracts a lot of attention, as do the first handful of search results. The logo is logically placed, in the area where the user has been most visually engaged and it is quite clear that the user has not been engaged fully enough to read all of the search results and their text.

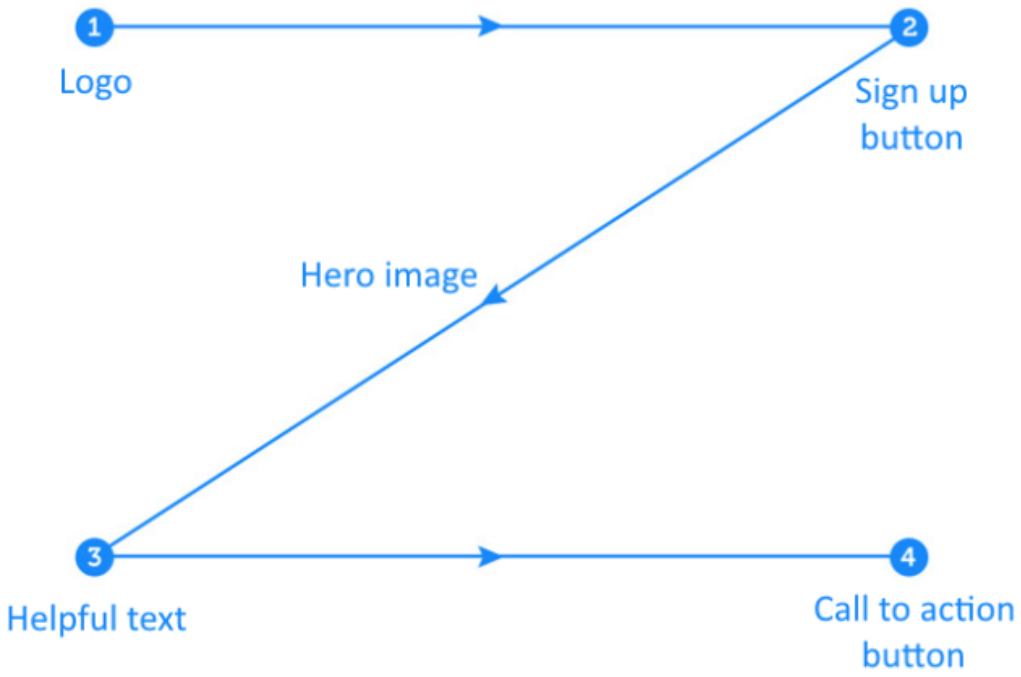

Figure 3: Z-Pattern scanning (Line 2019)

The “Z”-pattern also offers a logical and comfortable approach to designing the layout of a modern web page. According to Line (2019), the Z-pattern offers a logical solution to pages which contain all of the core information on one page. Hence, the Z-pattern would be more appropriate to multiple page designs, rather than single page designs.

Porter (2003) conducted research into the Three-Click Rule. The rule claims that if a user cannot find what they are looking for in three clicks, they will become dissatisfied and leave the web page. In Porter’s research, it was ultimately the fact that users would disengage, only if they cannot find what they are looking for and the number of clicks did not really have any impact. The Three-Click Rule is therefore subjective, though could still be relevant to consider when developing a web page. Global navigation should be available on every page, whether it be via the F or Z pattern, it should be simple, consistent and clear.

Reportedly in 2019, 53% of internet usage was from mobile devices (Bouchrika 2022). Smart phones have become so dominant in today’s market, that product design has begun to shift focus to the “Mobile first” philosophy. This optimises the User Experience of the product for those with smaller screens, in doing so this could increase the success of the product and brand (Morales 2021).

2.2 Software design principles

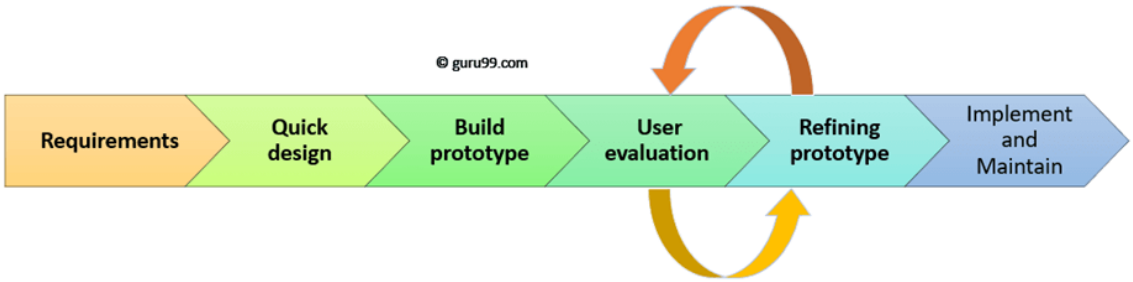

Figure 4: Prototyping Model Phases (Martin 2022)

Prototyping is an essential step in product design, wherein research is conducted for a preliminary product. Once the analysis and project requirements are outlined, the preliminary product is designed with limited capabilities, to enable stakeholders and or users to give feedback. Once feedback has been given, it is possible to understand whether the product is in fact feasible enough to begin refined versions

Prototyping models exist in a few forms: Rapid Throwaway, Evolutionary, Incremental and Extreme. Rapid Throwaway prototypes are typically visual exploration prototypes, which will perform more as a point of reference to the final product. Evolutionary prototyping is an incremental process and refined on feedback, until it has been accepted by the stakeholders. Evolutionary prototyping can be very useful in exploratory research fields, where new technologies are being developed and do not necessarily have competitors to base prototype models upon. Incremental prototyping is more of collaborative approach between different prototype models, where the stakeholders will decide and combine aspects of the provided prototypes into a singular entity. This type of prototyping can be very useful to save time resources and increase the rate of feedback for the developers. Extreme Prototyping however is more commonly found in Web development, wherein a basic prototype is built using rudimentary HTML formats, data simulations and finally integration of the data and UI/UX prototypes (Martin 2022).

In the iteral nature, close work with stakeholders and flexible nature of the project, it is quite common to utilise Agile Methodology in Software design. Scrum is an evolution of Agile which provides adaptive solutions for complex issues. Scrum is composed of a stakeholder (Scrum Master) who will outline a Product Backlog, a prioritised list and roadmap for the project. The Scrum Team will perform short and incremental sprints, collecting feedback and adjusting the scope of the project accordingly. The new sprint will commence immediately once the previous sprint has concluded. Scrum has been praised for it’s project flexibility and core values of: Commitment, Focus, Openness, Respect and Courage (Schwaber & Sutherland 2020).

2.3 Data visualisation design principles

Data visualisation is a process to enable to negate the need for analysis via pure text and numerical values, to enable the user to understand how to process the information intuitively and meaningfully. In doing so, businesses (for example) are empowered with being able to question on a deeper level and make more informed decisions. McCoy (2019) stated, “Accompanying text-based instructions with a graphic improved students’ performance on a test by a median amount of 89%.”, this also would imply that the Data visualisation itself was effective in stimulating the learning process.

“Good data visualisations are created when communication, data science and design collide” Islam (2019, 1) summarises a harmonious balance of how effective Data visualisation can be in Modern Business Intelligence and how Data visualisation speeds up data-driven decision making, however Data visualisation is not only designed for businesses. Data visualisation exists in a plethora of formats, whether it be fitness statistics from smart devices, tracking the latest popularity polls, understanding our energy consumption or even the weather. It is important to understand what makes the communication method effective with a few examples.

2.3.1 Bar Graph

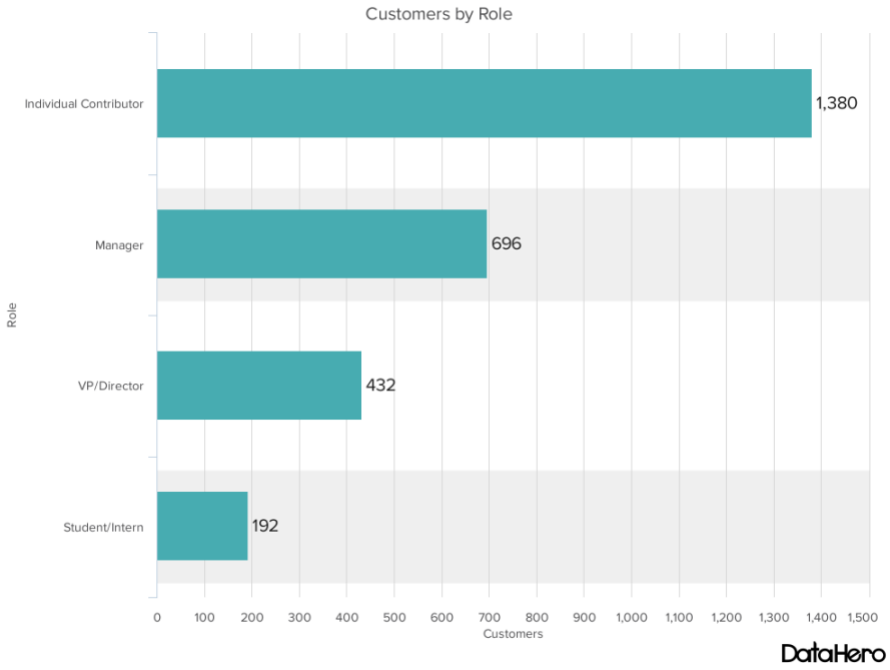

Figure 5: Bar Graph (Oetting 2019)

Bar Graphs are effective when we would like to communicate comparisons between for example the popularity of products or even opinion polls. In the above example, we do not need to examine for long to see the titles, values and understand what is being portrayed.

2.3.2 Line Graph

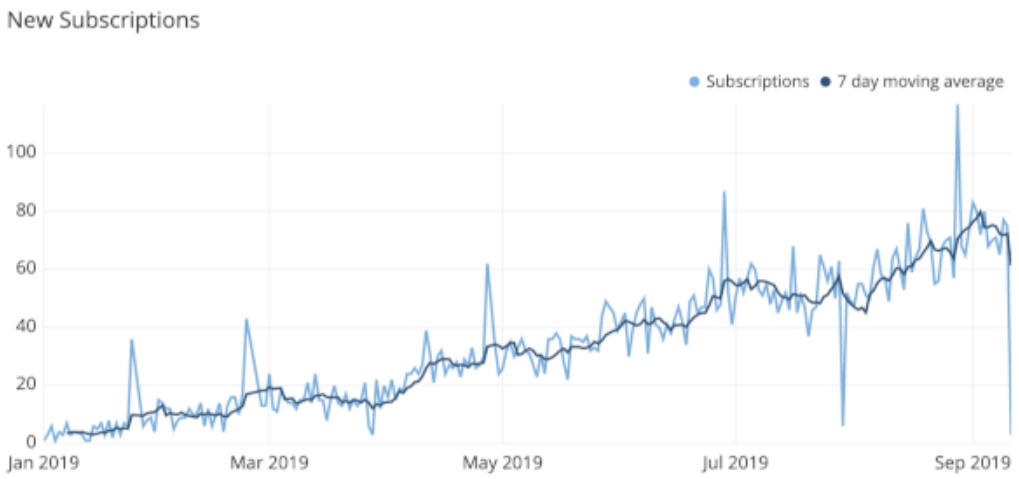

Figure 6: Line Graph (Yi 2022)

Line Graphs are especially useful when we would like to track progression vs for example time. Line Graphs also make future forecasting trends easily visually digestible. In this example, it is possible to quickly see that the amount of subscriptions are quite erratic, yet the line displaying the averages is much easier to follow and apply trend analysis.

2.3.3 Pie Chart

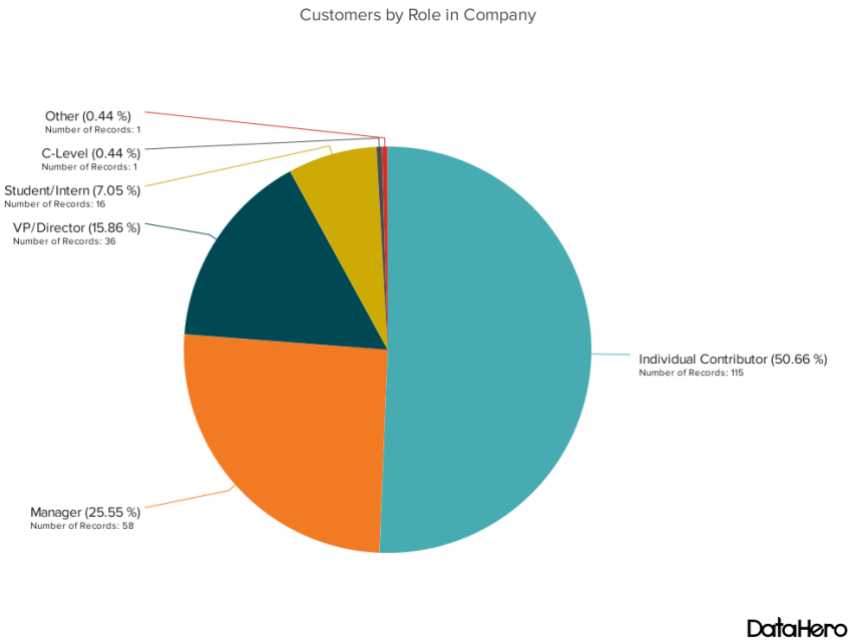

Figure 7: Pie Chart (Oetting 2019)

Pie charts are extremely useful when we want to analyse something as a whole entity. In the above image, percentages are clearly labelled, though even at first glance, we can see that the green percentage is dominant by roughly 50%

2.3.4 Bubble Chart

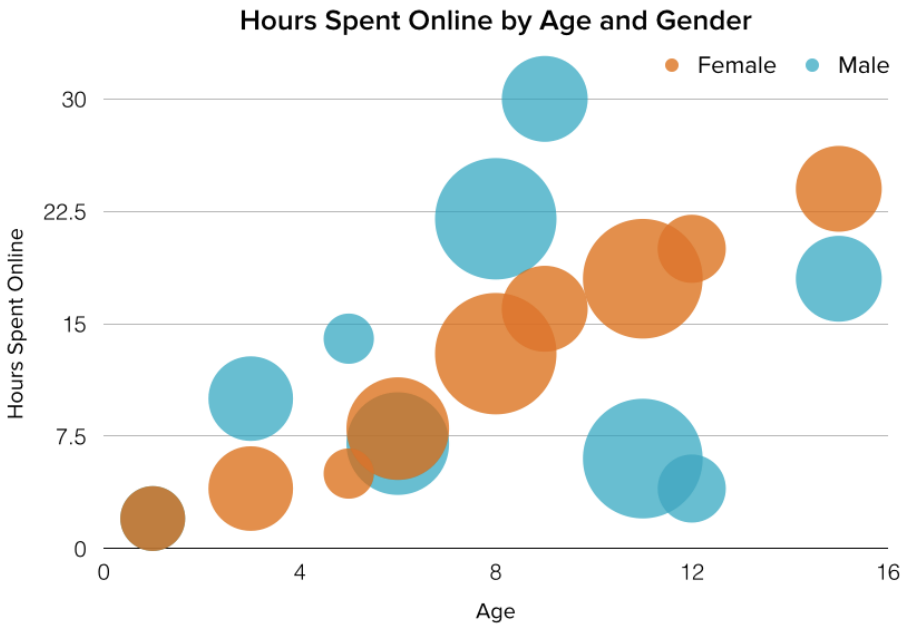

Figure 8: Bubble Chart (Oetting 2019)

Bubble charts are best applied when we want to understand the distribution or relationship that our values have with one another. In the above example, it is easy to understand that we have two different coloured categories and that we are understanding how many hours are spent online, correlating to age and gender. The size of the bubble however is left up to assumption, perhaps the amount of responses from that particular age and gender group.

2.3.5 Word Cloud

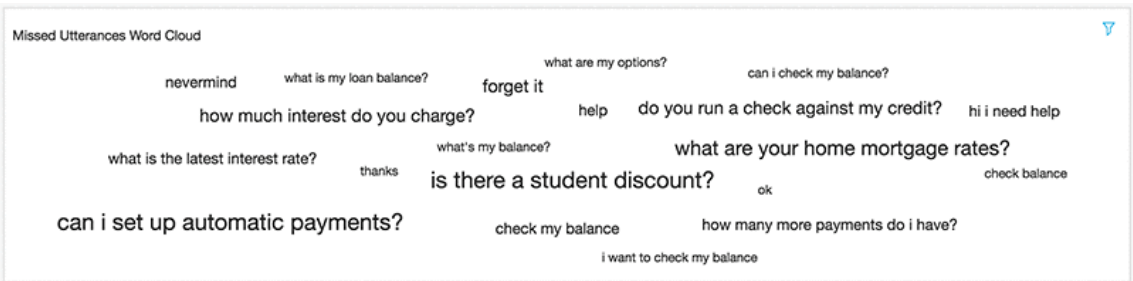

Figure 9: Word Cloud (Marshall & Yost 2020)

Word Clouds can be a powerful tool for understanding our audiences. In the example above, we have Amazon's Word Cloud for seeing common issues in their Lex Chatbot. If the Chatbot does not know how to answer a question, it appears on the Word Cloud, then font size depicts the volume or commonality of issues. The user is then able to understand that there are issues that need to be addressed with the performance of the Chatbot (Marshall & Yost 2020).

2.3.6 Misleading Practices

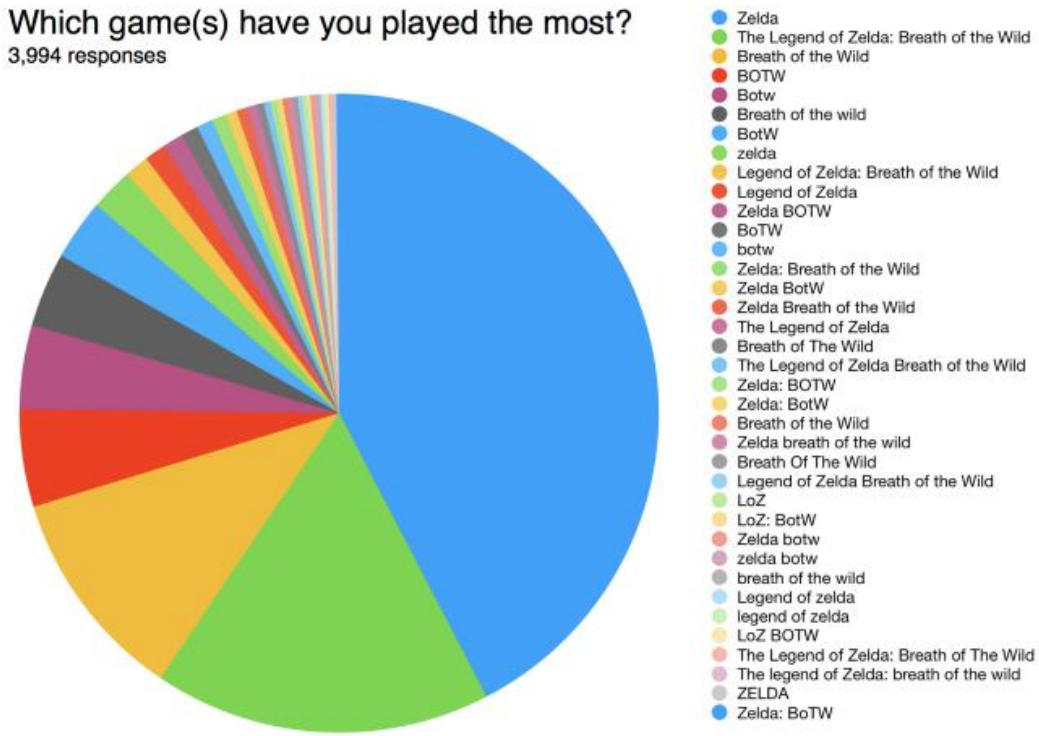

Figure 10: Bad Data visualisation Example: 3 (Fatima 2021)

Data visualisations can be very powerful, though it is important to understand that our visualisation can lack power, if the data is of subpar quality and vice versa. In the above image, Fatima (2021) displays how misleading and difficult to understand a visualisation can be, if the data has not been formatted to a high standard. The data is compiled of a survey of video gamers' Most played games. Here, the results are compiled of all of the same result yet spelt slightly differently. Fatima also elaborates that the visualisation is far too complex due to the sheer amount of variables, making it hard for the viewer to process the data, similarly so with the indifference of the colour scheme.

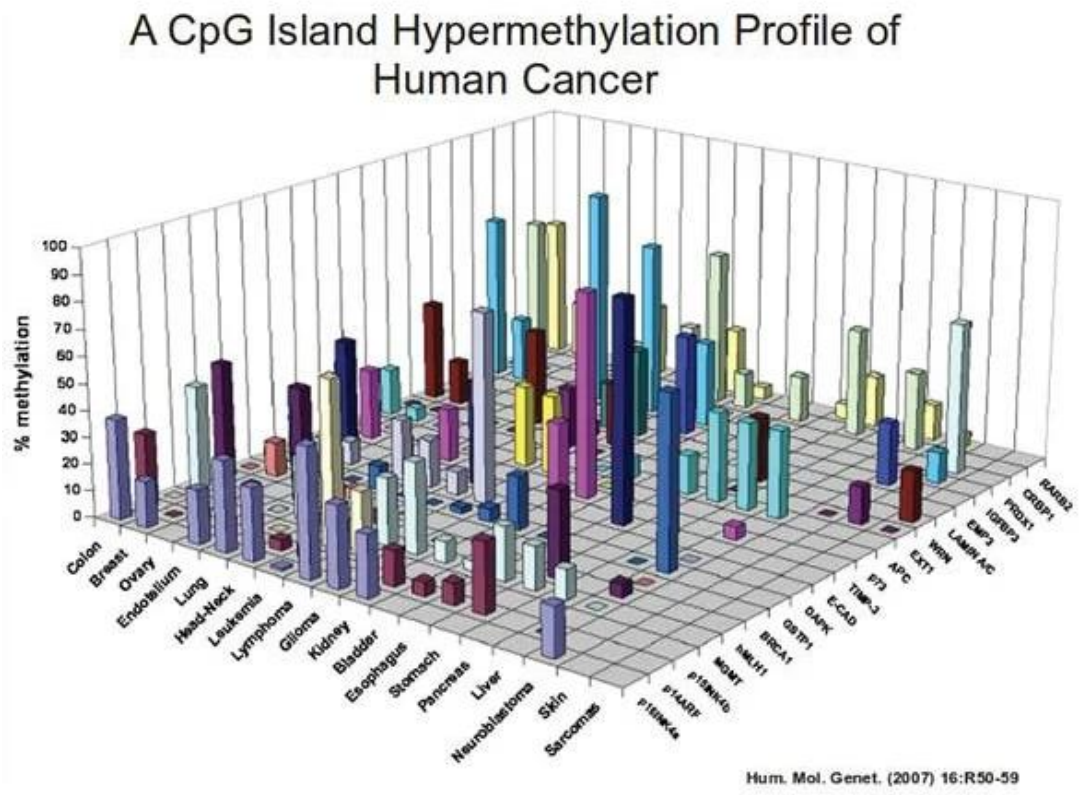

Figure 11: Bad Data visualisation Example: 1 (Fatima 2021)

Fatima (2021), once again outlines the difficulties that too many variables can create, yet this time with Three Dimensional graphics. The extra dimensional factor can certainly hinder the understanding process, as we can quite clearly not see all of the data set at once immediately, let alone easily reference each data set with the axis labels. Fatima's examples of misleading Data visualisation contain valuable factors to contribute to the necessity of planning and polishing Data visualisation and data sets. Similarly, Islam (2019, 9) reiterates the importance of the harmony of the data and the visualisation, "Effective data visualisation should be substantive and while creative visuals can enhance interest and memory, embellishment can't make up for a lack of substance".

3 Artificial Intelligence Solutions

Headai Oy offer numerous intuitive Artificial Intelligence solutions. A prerequisite of this Case Study was to integrate their solutions into the final implementation of the project.

3.1 TextToKeywords

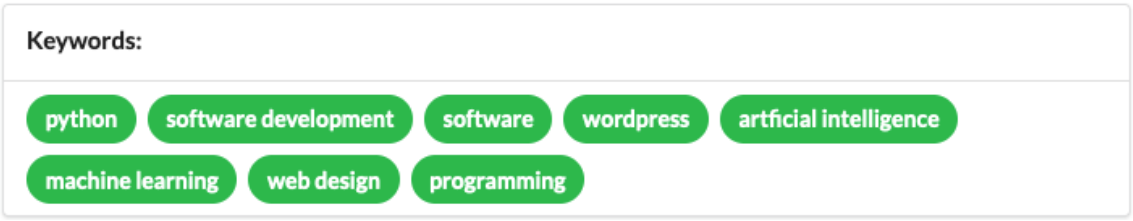

Figure 12: TextToKeywords (CareerBot 2022)

TextToKeywords is an Artificial Intelligence solution which communicates data via API calls as JSON data. The TextToKeywords solution is an unsupervised machine learning Artificial Intelligence, based around Self-Organising Maps. Text is inputted, sent via API calls, analysed and returned as JSON data containing words, their relations and relevancies to one another (Headai 2022d).

The TextToKeywords solution is implemented in a 3AMK collaboration project, wherein the students are able to utilise the solution to: “Verbalise their skills”, “Find jobs with their skills profiles”, “Find courses for skill development” and “Find theses and research topics” (3AMK 2021).

3.2 Document Parsing

Document parsing was another prerequisite for the prototype. By enabling the teacher to upload a document to be analysed by the Artificial Intelligence, the teacher would be able to begin creating their study content with less effort. The teacher would also have the option of free text input, by describing the course, the Artificial Intelligence would have more keywords to create content from. (CareerBot’s Skills Profile input section includes a .pdf / .docx Document parser, which was further developed during the author’s work placement).

3.3 Concept Maps

Concept Maps utilise the basis provided by the TextToKeywords solution’s Self-Organising maps. Concept maps can turn complex data into easily understood visuals. The JSON data is transformed into a visual tool that provides analysis via Artificial Intelligence and conceptualisation of the relations into maps.

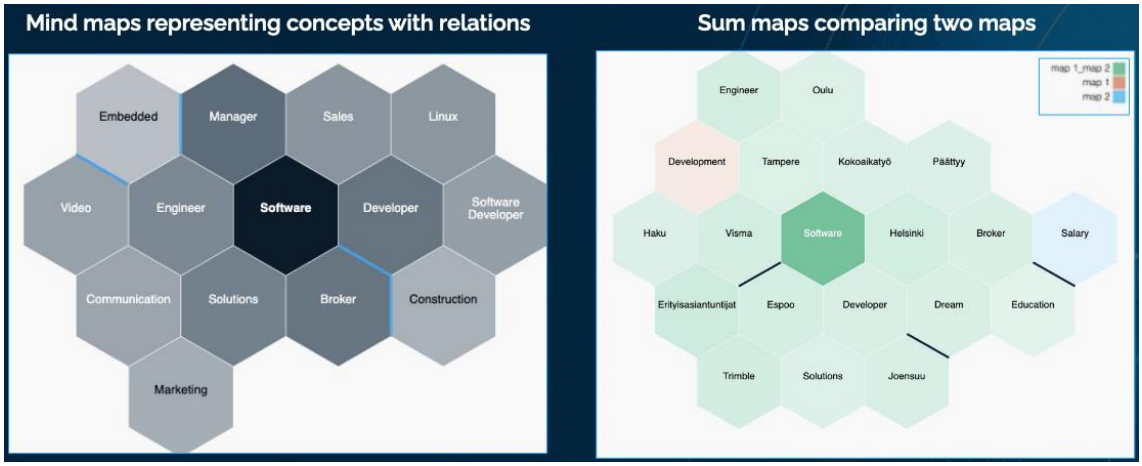

Figure 13: Concept Maps (Headai 2022c)

The Mind map displays the most found concept in the centre and in darker colours. The least relevant concepts in lighter colours. The concepts are arranged as per their relevance to one another, division lines exist to show a lack of relevance. The Sum map offers a deeper level of comparison, as more than map can be cross analysed with one another, through different layers (Headai 2022c, 13).

3.4 Learning Support

Fast Degree is another Artificial Intelligence solution provided by Headai. Fast Degree provides an initial test that the student will take, once the test is taken, Fast Degree will offer learning materials to the student in areas in which the student is not as knowledgeable. Additionally, Fast Degree has learning support in the format of providing the materials that the Artificial Intelligence has processed, be it videos, books or news (Headai 2022b).

4 Initial prototyping

A list of criteria was set at the very beginning of this task by the client. Creative and additional logical input was very welcomed by the client. Initial steps were outlined as the user's experience on the platform, they follow as such:

1. User logs in via an authorisation service available to students.
2. Courses can be created by inputting text or a document.
3. Course templates can be used for future content creation.
4. The content is sent via API to be analysed via Artificial Intelligence.
5. Results are brought back as a hierarchical data set.
6. The data is displayed in a visual map, which shows the proximity and strength of the data's relationships.

7. Data must be easily editable, to ensure the learning materials are as expected.
8. The teacher can then invite students to begin studying.
9. Students interact with the visualised data and begin assignments set by the teacher.
10. Teachers and students can easily see progress.
11. Enabling feedback via likes and popular content producer's will be promoted.
12. Teachers are able to contact their students to finish their studies on time.
13. Learning materials can be exported as readable text for other Artificial Intelligence projects.

The client had informed the author that very basic wireframes would be suitable for the initial ideation stage. Wireframes are two dimensional representations of potential solutions to UI and UX. After previously conducted research, the appeal of having something more than pure typesetting (Lorem Ipsum) and colourless boxes representing interfaces was rather underwhelming. A blend of Evolutionary and Rapid Throwaway prototyping deemed to be a more involving process with the stakeholder, to be able to visualise a potential solution, that looks like a real solution. The idea was to provide these more engaging visuals as a story board (commonplace in Service Design) that wake further collaborative idea development.

Whilst there are many products aimed at providing such solutions, (Adobe XD being a prime example) the author has gained much experience with Wordpress. Working with Wordpress then would provide useful insight into whether the Content Management System would be a valuable framework for further developments. Any constrictions (time or available technical resources) would be negated by the use of photo editing software, for the purpose of these initial Throwaway / Evolutionary prototypes.

Please note that the following prototype images are from the final Throwaway prototype stage and will feature only the most relevant steps (twelve storyboard steps removed). Additionally, the naming of courses will be referred to as "NanoCompetencies".

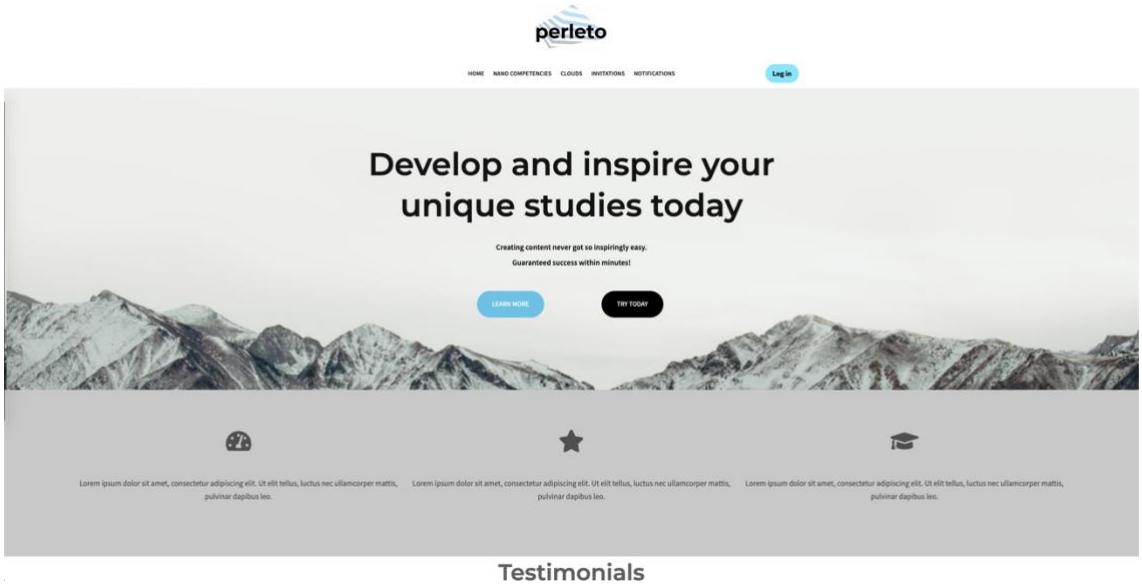

Figure 14: Home page and navigation

The idea was to experiment with the Z layout and feature images, links and generic slogans. A logo designing website was utilised to have a generic beginning that matched the Wordpress template's selected stock home page image.

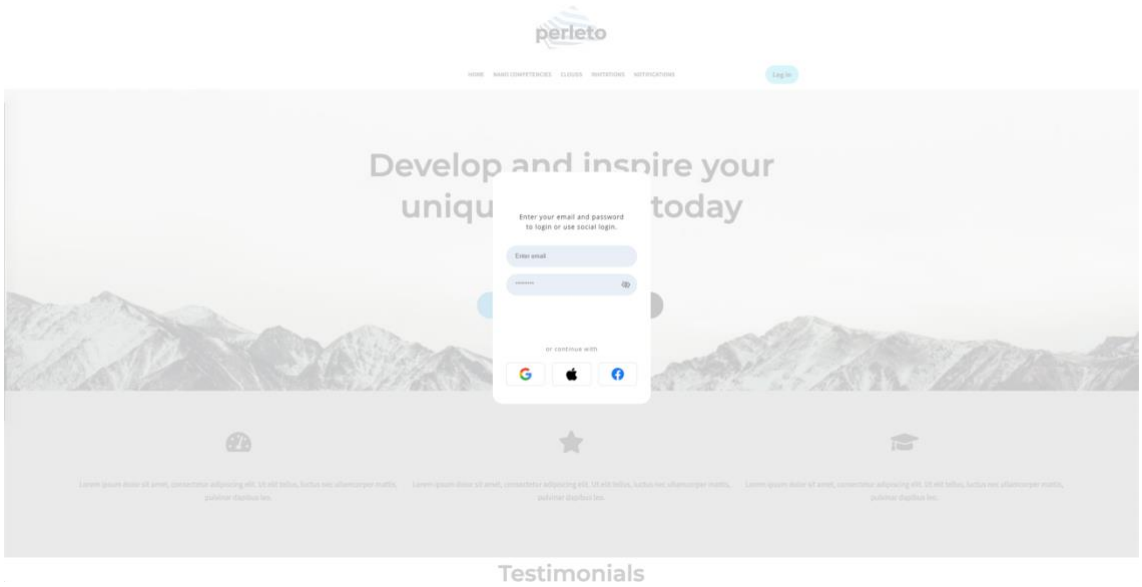

Figure 15: Authorisation

User login modal opens, as the platform would potentially be offered to more than Laurea students, typical authorisation services to be used (Google or apple to name a few).

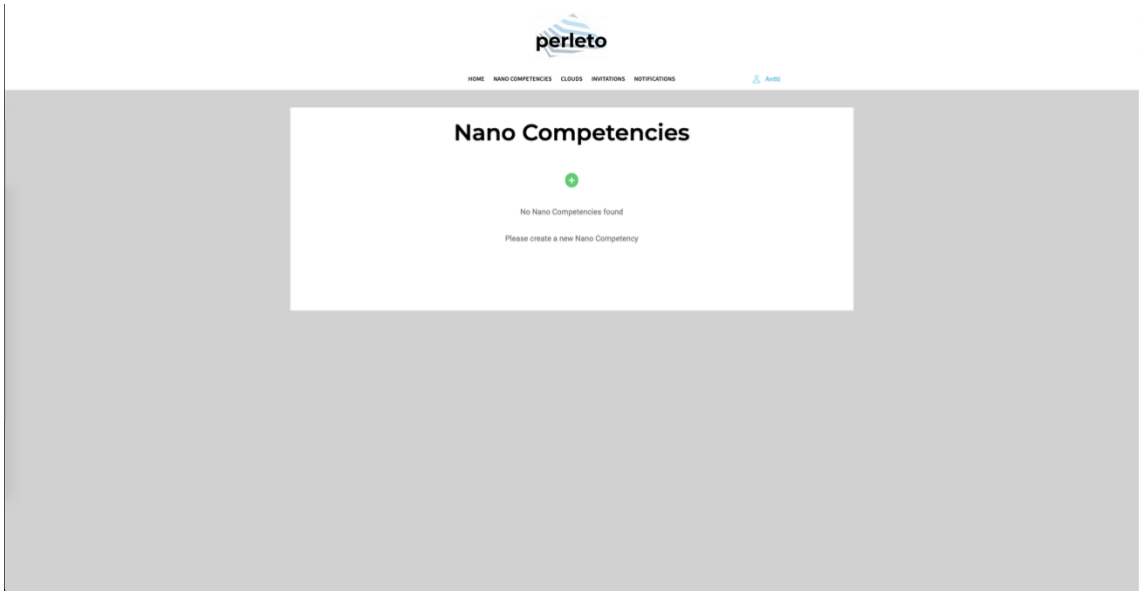

Figure 16: NanoCompetency creation page

Empty NanoCompetency list page, for the creator to begin creating learning materials.

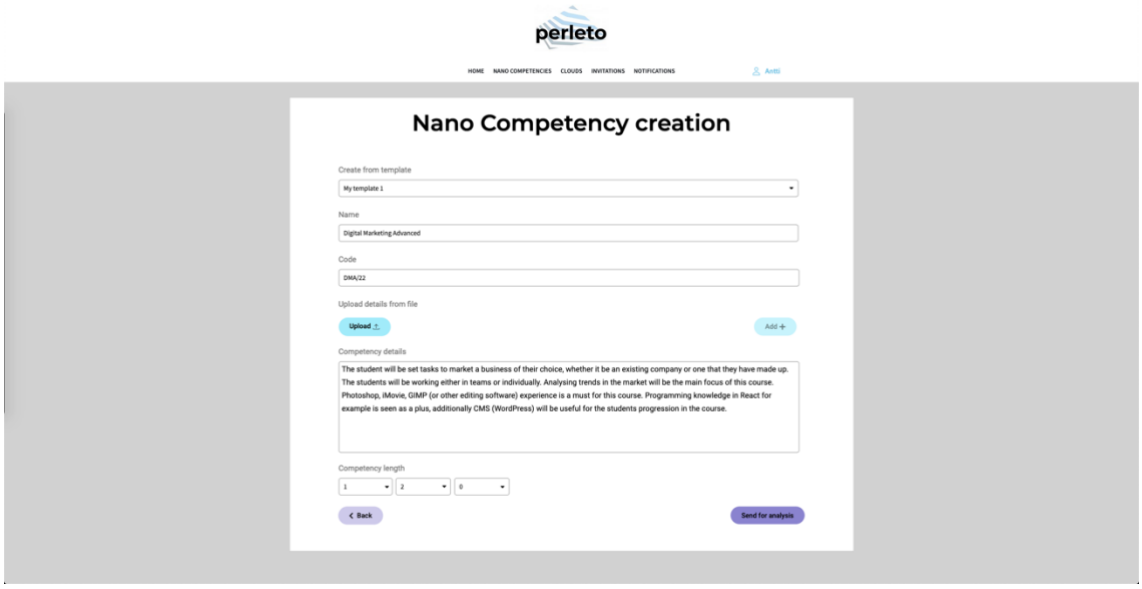

Figure 17: Creating content for NanoCompetencies

A document can be uploaded for the Artificial Intelligence to analyse core content from the NanoCompetency description. NanoCompetency templates can be utilised to provide a content structure to speed up creation.

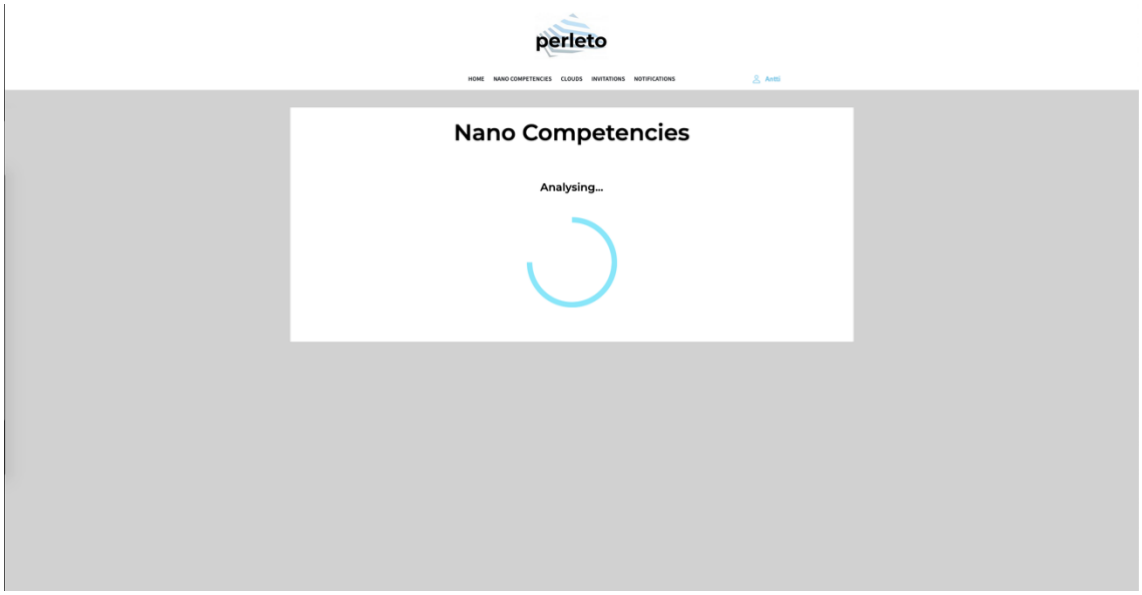

Figure 18: Content analysis

The form is sent via an API call to Headai's servers for the Artificial Intelligence's TextToKeywords analysis, which will only output the relevant skill keywords which it has found from the submitted document.

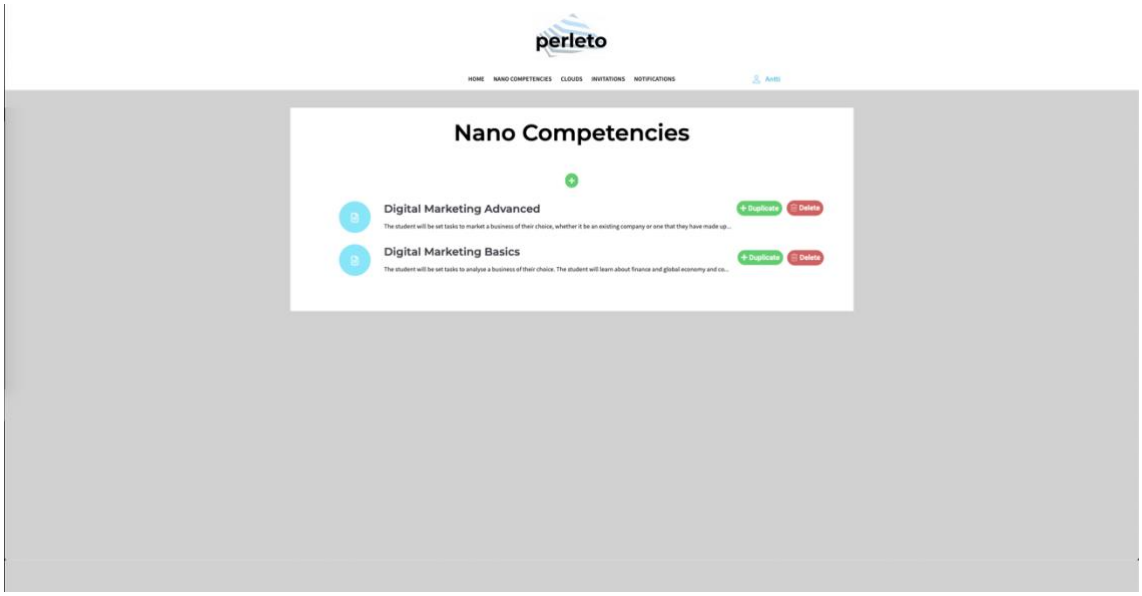

Figure 19: NanoCompetency list

NanoCompetencies have been created and is ready for analysis and editing.

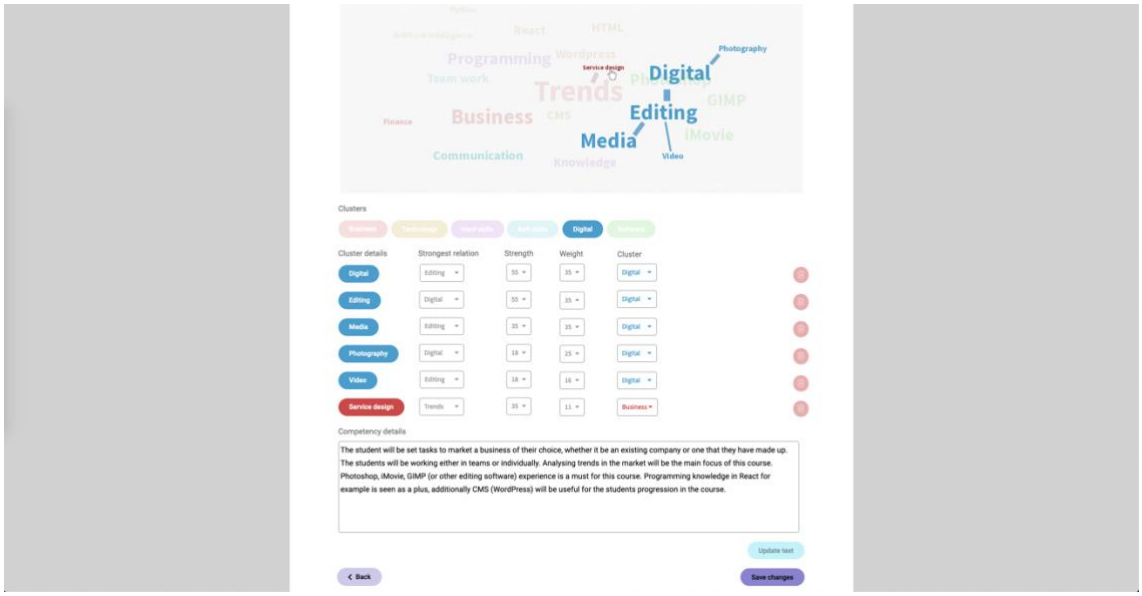

Figure 20: NanoCompetency editing

The Artificial Intelligence has returned the learning materials. The NanoCompetemcy creator is now able to begin editing the word cloud. The word's size represents it's relevancy and the connecting line signifies the strength of the closest relation.

Figure 21: Learning materials

Students land on this page once they have signed up. The student is able to see from the grey dots that there is a missing assignment and begin the studies. Once the assignments have been completed, the dot will illuminate in green. The students are able to download the NanoCompetency data as JSON data or .png image and like the content.

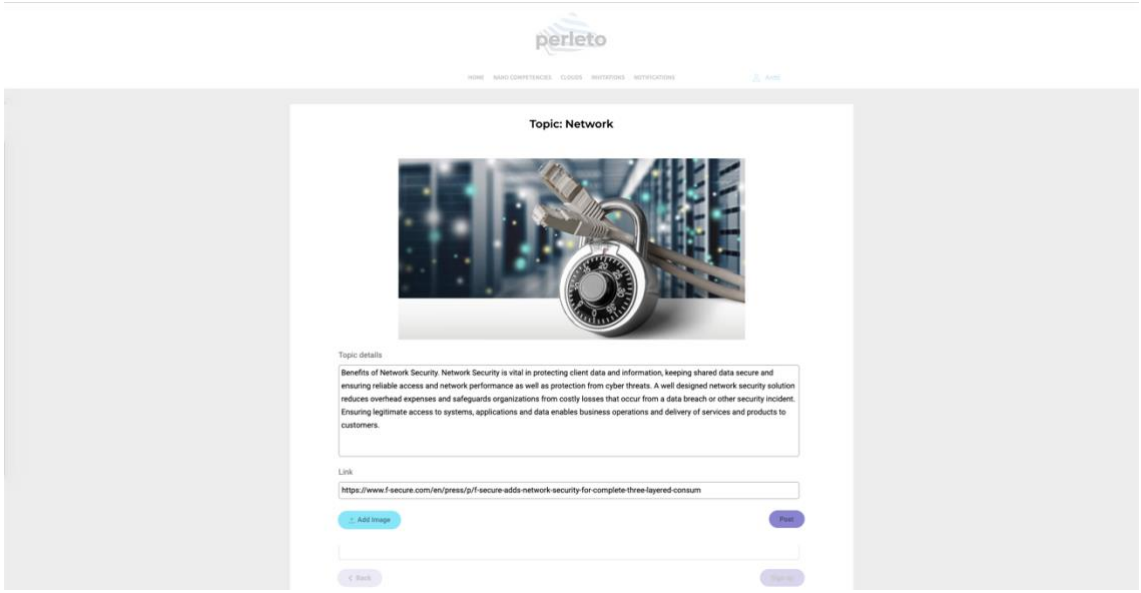

Figure 22: NanoCompetency task submission

Per word on the cloud, the student must write about the selected topic and the relations. An image can be uploaded and reference links. The student has elaborated on their understanding of the “Network” task.

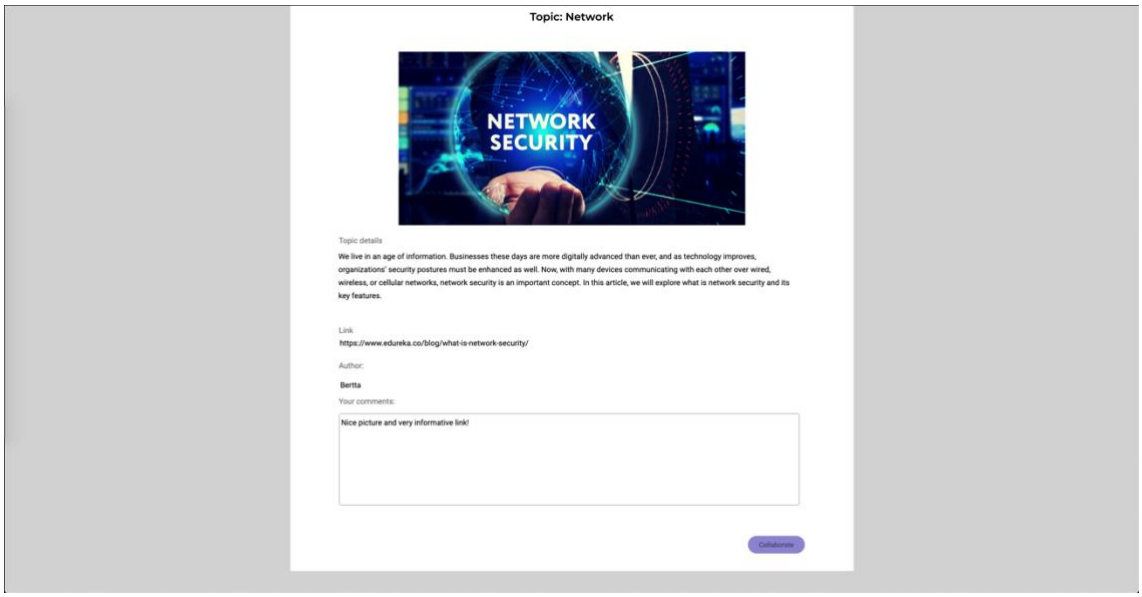

Figure 23: Study collaborations

Students can see the works of others and support peer-to-peer learning and collaboration.

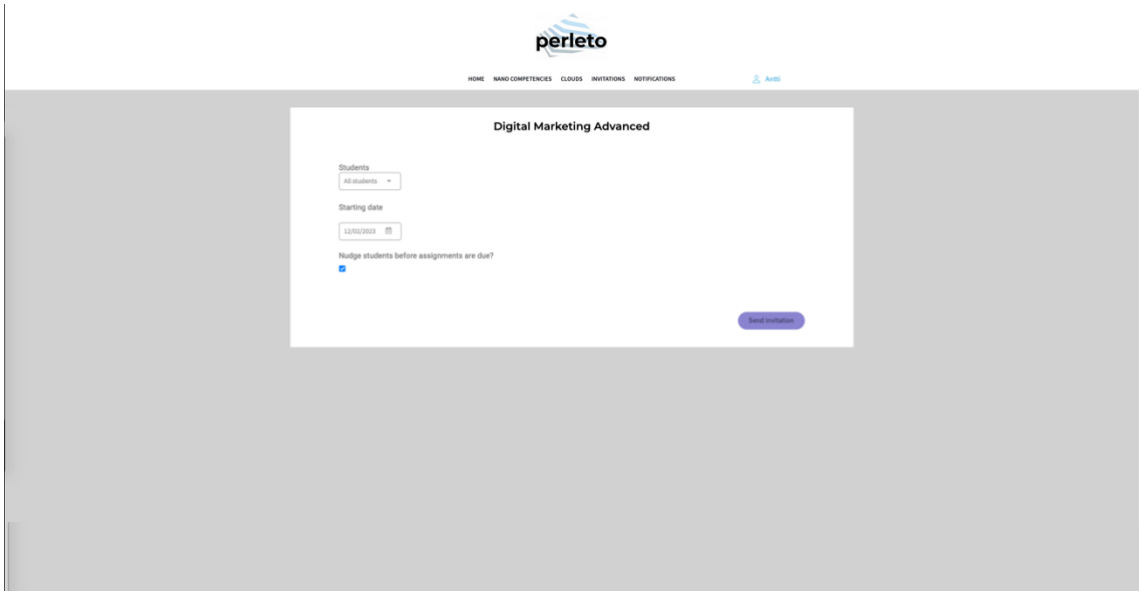

Figure 24: Invitations

The NanoCompetency creator would be able to invite potential students to begin work on their content. Notifications for deadlines would be possible to set up automatically.

Figure 25: Assessment interface for NanoCompetency creators

The NanoCompetency creator can see from the word cloud how the progression of studies has gone via the traffic light-coloured circles and see further details in the table. Students can be reminded to complete their assignments.

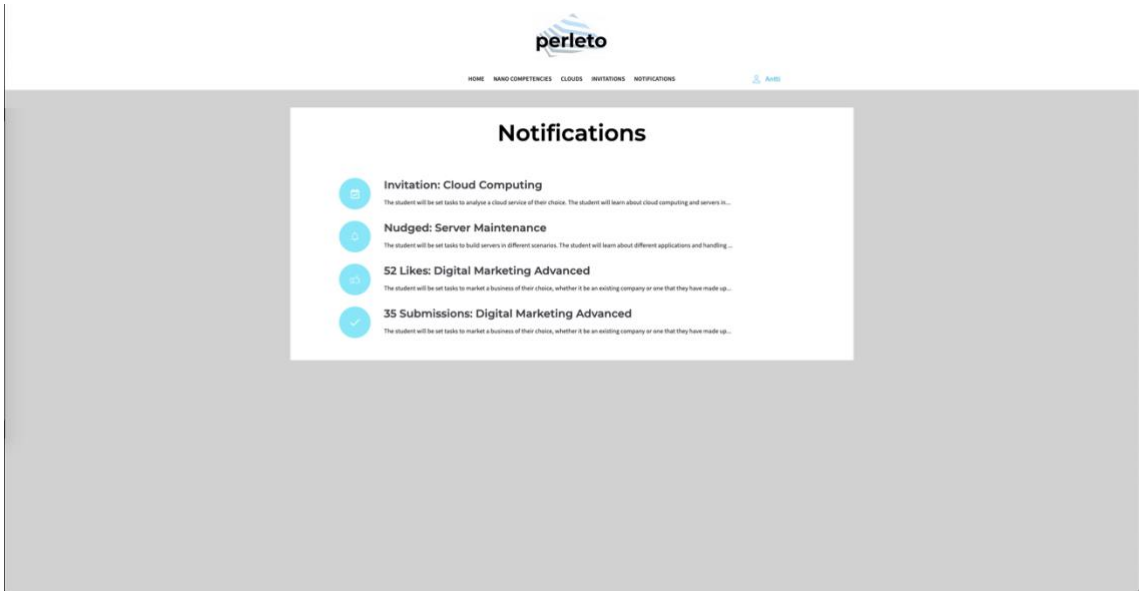

Figure 26: Notifications

A list of notifications of the activity within the platform.

5 Build frameworks

As the initial prototype met a warm reception from the client, it was now time to evaluate the steps that had been taken so far. Primarily, the frameworks and libraries to begin building the Extreme Prototype.

The combination of Wordpress and Elementor was a powerful solution for a visual representation, however these solutions deemed to be more powerful for more static web designs. The justification for this conclusion is that image editing was still necessary to provide some essential tools on the interface and most importantly the data flow.

5.1 Front-end frameworks

According to Statista (2022), the two most used web frameworks used in 2022 follow as such: Node.js 47.12% and ReactJS with 42.62% of the market share. While ReactJS comes in second, ReactJS is more dedicated to Front-end development, while NodeJS is a Back-end framework. ReactJS enables web developers to create websites or websites within their JavaScript framework. React features high performance dynamic libraries, whilst still supporting HTML and CSS. Developers can download third party libraries to incorporate numerous integrable features to speed up workflow. The open-source nature of the framework enables community development and the popularity of the framework ensures that compatibility issues should be minimal (Tkachenko 2021).

5.1.1 User Interface

There are many component libraries derived from Bootstrap. These component libraries increase workflow and productivity by enabling developers to download the package (via Yarn or NPM) to their project and be able to use styling components. These components can include: forms, buttons, notifications, lists and many more user interface components.

Whether it be Semantic UI, Ant Design, React-Bootstrap or Material UI it can be a personal preference. However, there are pros and cons to each component library, be it paid “pro” content or limitations on customisation. The author had been previously working with Semantic UI in their work placement on another project. The author had run into creative and technical issues with the component library on numerous occasions and felt it best to research new options as this Case Study is for a separate project.

After research and experimentation, the author found Material UI to be the ideal option. Material UI do offer paid themes and components, however the standard library gives much flexibility with minimal effort. The documentation and examples are very easy to understand and very in depth. Material UI’s components excel at speed and Server-Side activity (Stackshare 2022). Many corprorations utilise Material UI’s component library, including: Spotify, Amazon, NASA (Material UI 2022).

5.1.2 Data visualisations

Once again, there are a plethora of options for Data visualisation and React. D3JS offers JavaScript capability of manipulating SVG (Scalable Vector Graphics). The author had much experience with D3JS in their work placement, however the nature of the customisability had a large impact on time resources. D3JS seemed to be rather simple to implement in HTML, as the JavaScript framework, however the translation of D3JS to ReactJS could be so time consuming that the results were not necessarily as desirable as the author would have wished.

AmCharts is a solution to this problem, AmCharts still requires much configuration. However, from a workflow perspective, it makes much sense to utilise solutions that already are eye-catching out of the box. There are many common and uncommon charts and graphs: Bar, Line, Gantt, Maps, Stock Chart Candlesticks, amongst many others. Amcharts utilises Canvas API, which tends to be faster to render than SVG (AmCharts 2022). When learning how to work with new languages or libraries, documentation can tend to provide pitfalls, thankfully AmCharts features fantastically in-depth documentation on how to implement and customise their products.

5.2 Back-end frameworks

In the case that this product would be further implemented, the author believes the Front-end design to be more fundamental than the Back-end, as much of the Back-end functionality could be outsourced. The Back-end has been implemented for the functionality to demonstrate to the stakeholders.

5.2.1 Hosting

The product would need to be hosted on the cloud for feedback and testing. The product is to be deployed to GitHub and pushed to a cloud hosting service. After testing a few options of hosts, the author had issues which were very time consuming to debug. Pushing to the initial services itself was rather time consuming. The author then tried Vercel, deployment happened immediately. Vercel provides optimal speed and no nonsense.

5.2.2 Database

Naturally, if the prototype is to be functional, a database is required for user data and authorisation. Google's Firebase is a powerful option as it offers an "all-in-one" solution providing: Authentication, Cloud Storage, Database, Real-time Database, Cloud Messaging, Performance Analytics to name a few functions available. Firebase is free to begin working with and has extensive documentation.

5.2.3 Authentication

Authentication could have been provided by many, perhaps most logically from Google as the database side of the application is hosted there. In the manner of this platform being for education, it made sense to the author to experiment with other authorisation providers, and particularly one that is used in educational institutes. Microsoft seemed the sensible option here, as it is utilised in Laurea University of Applied Sciences.

5.2.4 Data structuring

Unquestionably JSON data is utilised on the platform, to maintain potential compatibility with the Artificial Intelligence solutions. JSON is a hierarchical data structure and will be sent and called via API calls. The data structure will be unique for separate aspects of the product, be it for NanoCompetency content, notifications, Data visualisations and more.

6 Final Prototype

During the course of the Throwaway Prototype, much was learnt regarding the structure and necessity for the right components to build the Extreme Prototype. The prototypes share much in design, though ideas were easier to develop and build, once the composition of the Prototype began to take form. The Extreme Prototype currently is composed of roughly over 40 pages of code.

In the following chapters, the author preferred to widen the terminology of “NanoCompetencies” to content, as discussed with the client, the term could well be only a working title of the learning content, as the length and depth of the studies could develop further than the extent of the word “nano”. Furthermore, it is unclear whether the contents will only be created by teachers, hence the creators will be referred to as “content creators”.

The following images demonstrate the Prototype’s build, logic and functionality.

6.1 Home page and Navigation

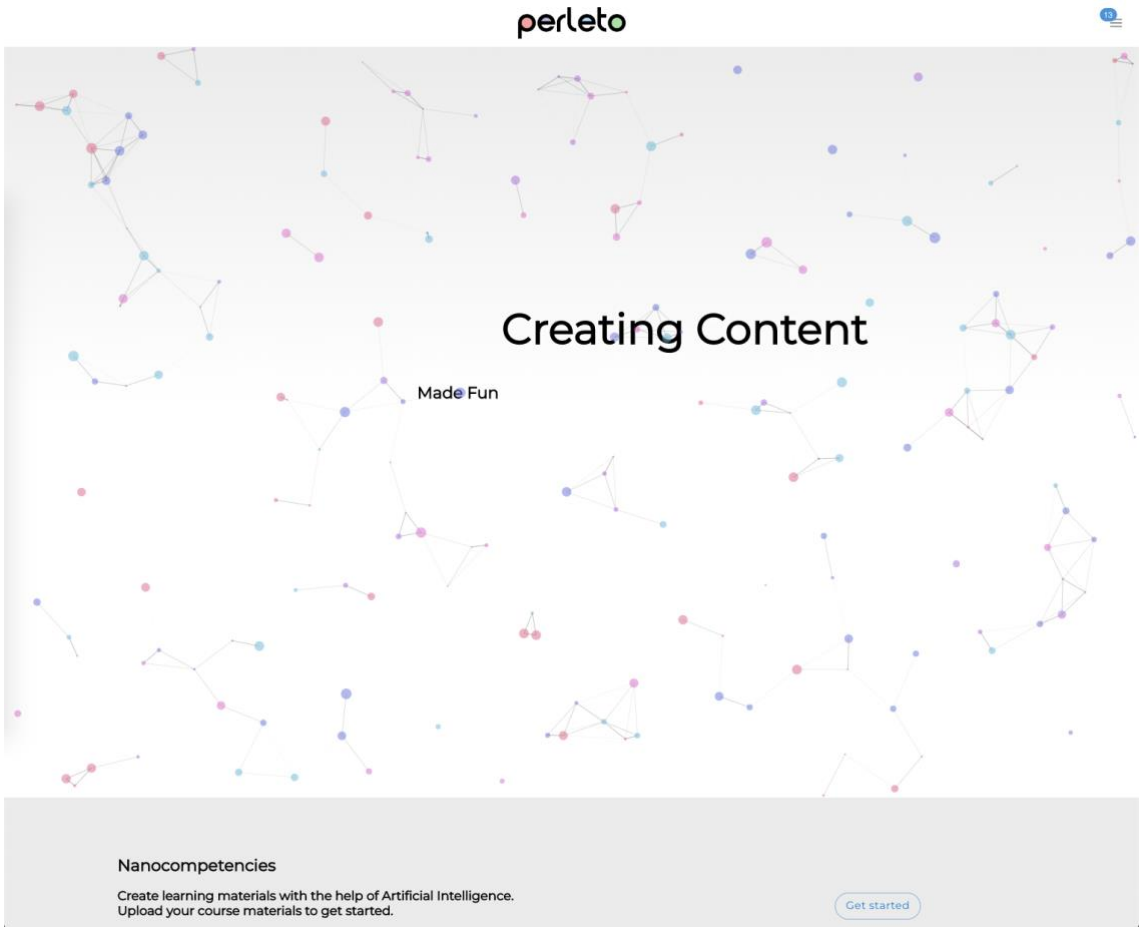

Figure 27: Prototype Home Page

The user will navigate to the address of the page and find the home page. In place of the Menu Icon, the user will find a Log In button. Once clicking the button, a popup window will enable the user to log in via Microsoft's OAuth service which is connected to the project's Google Firebase service via React-Redux's Dispatch. Once logged in, a "snackbar" a notification from Notistack component library will welcome the user by their name. The user will now be able to access the platform's content, via the Menu Icon which appears in the place of the log in button. Rules have been set up in App.js to redirect the user only to the home page, should Firebase return that authorisation is false.

The page has been laid out in the Z layout, as the author and client deemed this to be more modern, simple and eye catching. The structure of HomePage.js is quite simple, a container to house the content on the home page. The background of the home page is called from ParticlesBG.js. TSParticles component library provides an interactive and animated node and connection background. The author found this to provide a more unique first impression, which also relates to the particular style of Data visualisation that the platform utilises the most. HomepageFadeText.js is then loaded, wherein animated text will fade in and out explaining simply and in as few words as possible the purpose of the platform. The purpose of containing the fading text in another file is to prevent certain components (background for example) from rendering once the text's functionality starts from the beginning. The re-rendering causes a jittery effect and is not a desirable first impression. The remainder of the home page is to expand in slightly more detail and contain images which could stimulate interest from potential users.

Figure 28: Prototype Navigation

The author wished to keep the navigation as simple as possible, less clutter and keep the mobile first approach by containing all navigation into a menu. The NavBar.js has equally been kept simple and clean. Firstly, the author's prototype logo design made with GIMP image editing software. The idea was to find a modern, readable, yet perhaps unusual font. Then to utilise western colour psychology: red "stop", purple "wisdom", blue "inspiration" and green "success".

The menu starts with a profile icon in an Avatar component. The user name will be split to display only the first initials of first name and last name, the colour will be assigned differently for each name. Next to the Avatar, the user's name provided to Microsoft's OAuth will be displayed. The navigation areas are as follows: Home, NanoCompetencies (studies), Discussion Board, Notifications, Help and finally, Log out. The notifications are the Badge component, which displays to the user on the menu icon and relevant navigation fields, that their attention is required. All icons featured are imported from tableIcons.js, all of which are provided by Material UI.

6.2 Onboarding and help

In the opinion of the author and client, it can be slightly difficult and perhaps overwhelming to learn how a new platform works and to realise quickly what kind of features are available. The importance of a welcoming help and a static help function is an effective way to quickly enable all users to realise what is available.

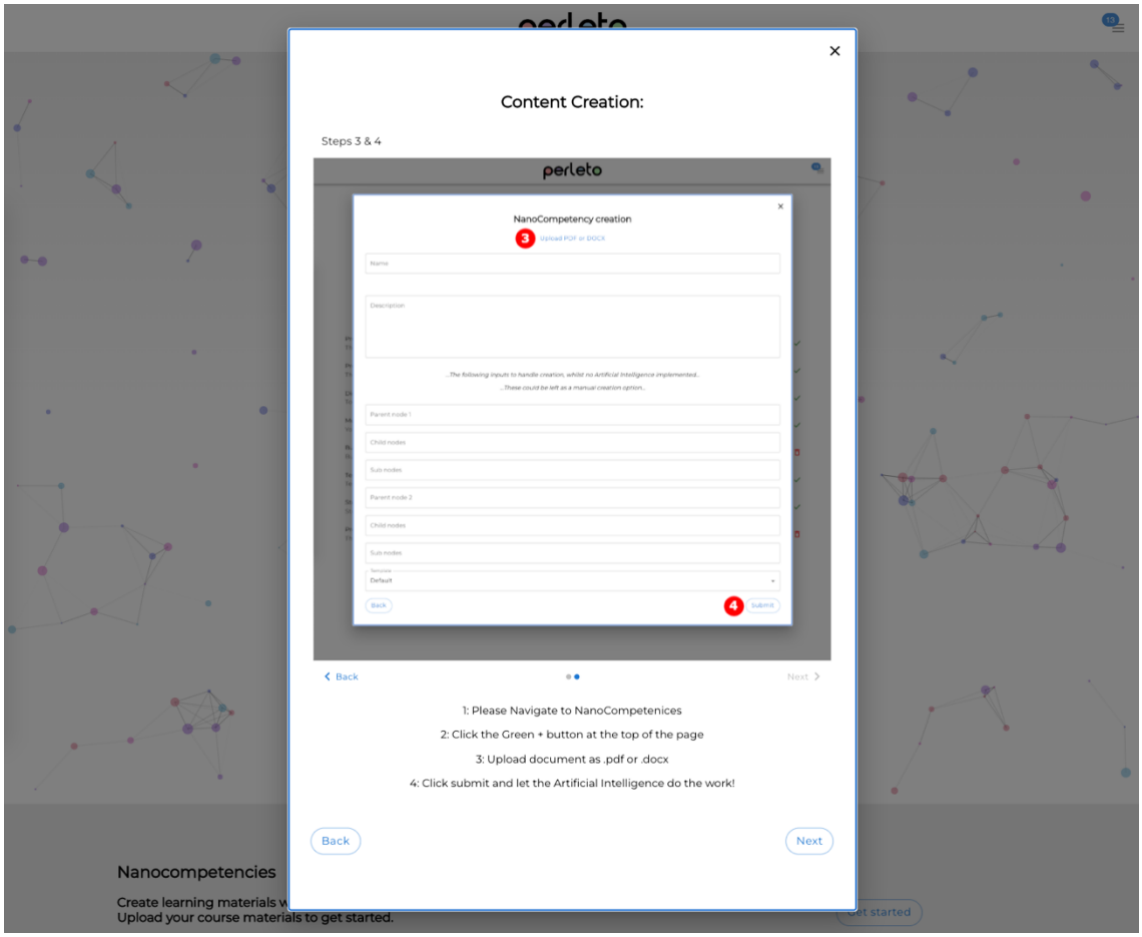

Figure 29: Prototype Onboarding and help

Once the user has logged in, Firestore's records of whether lastLoginAt is an empty string. If the string is empty, this means that a new user has logged in for the first time. An onboarding modal opens and welcomes the user by their provided name. The user will be asked whether they are a content creator or whether they are a student at the press of a button. Regardless of the answer, the user will be directed to useful tips on how to get started and how the platform functions, tailored to their initial answer. Both options will lead eventually to common areas, which are shared between both sides, notifications would be a good example of a common area. In the above figure, we are viewing the onboarding for the content creators.

If a user is not sure how something is done, the onboarding modal is available from the menu under the help option. The user will however not be welcomed as a new user, only provided the options.

The onboarding is built with React-swipeable-views component library to provide the carousel image functionality.

6.3 NanoCompetencies list

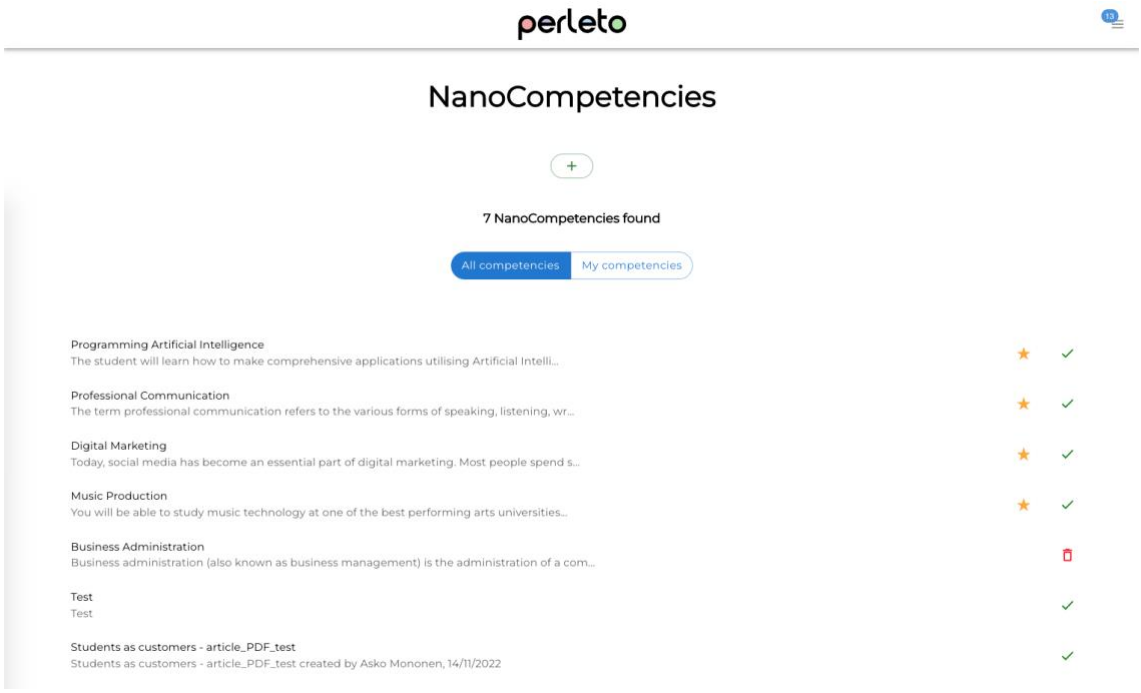

Figure 30: Prototype NanoCompetency list

The user will land on the NanoCompetencies page, wherein there is a list of content which has been requested from Firebase's Firestore. If the list would be empty, the user would be prompted to create new content. The list is fairly simple, including: Title, description (limited to 90 characters) and Icons. The Star Icon represents that this content has been

created by one of the top 5 content creators. The Tick Icon represents signing up to study the NanoCompetency, however, the student is given the option of viewing the content by clicking within the boundaries of the list item. The Bin Icon is only available to those whom have created the content and wish for it to be removed from the list. Each icon has a Tooltip, if the icon itself is not self-explanatory enough, the user can read the relevant information of the purpose of the icon.

If the list were to be many pages in length, then the content creator might not be able to find their NanoCompetency, the “My Competencies” button will filter all from the list, which do not contain the user’s unique identification code, provided by Microsoft’s OAuth service.

6.4 Creating content

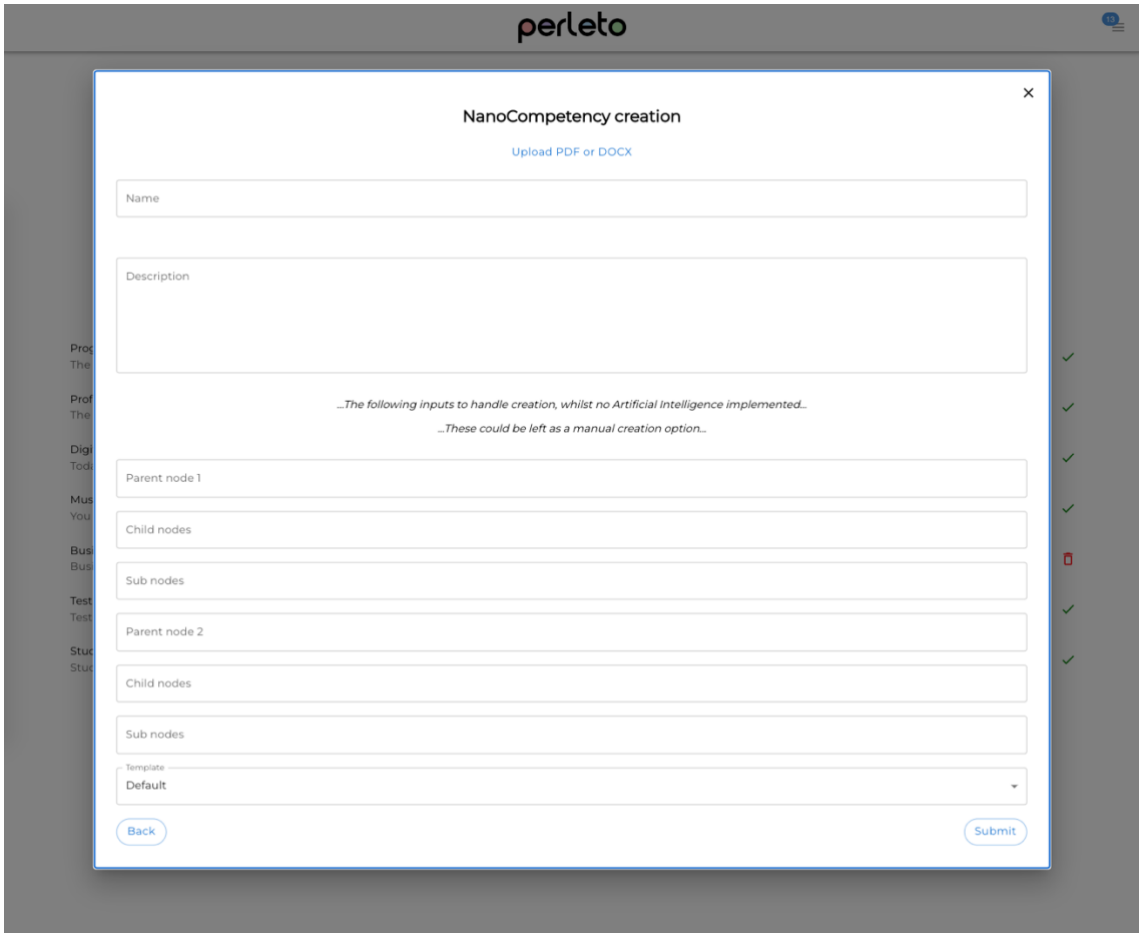

Figure 31: Prototype NanoCompetency creation

Upon clicking the green plus button in the NanoCompetency creation page, a modal window will open. The first visible button that appears is for uploading a document as .pdf or .docx. The purpose is to simplify the content creator’s creation process by gathering information via Headai’s Document Parser, into the description box. All of the readable text from the

uploaded document will then be editable by the content creator, to be sent off for analysis by Headai's TextToKeywords solution. The Artificial Intelligence would then return appropriate skill keywords and their appropriate numerical values required in the upcoming steps.

For the purpose of this prototype, the Artificial Intelligence has not been authorised to utilise. However, the prototype enables the content creator to manually assign starting values. The values are populated into two separate groups containing: Parent Node, Child Node and Sub Node. The Parent node is central to the relevant skills, much like the sun in our universe. The child nodes can be easily explained then as the planets and Sub nodes, their moons.

Once these skill keywords have been populated in the relevant text fields, the content creator can select from a template (currently only two for demonstrational purposes). The templates contain varying numerical values to begin the creation process and are stored in separate files (Default.js for example). Once clicking the submit button, information is sent to Firestore, a notification will notify the user of successful creation and the list is repopulated. The content creator can then navigate to their newly created content.

6.5 Editing content

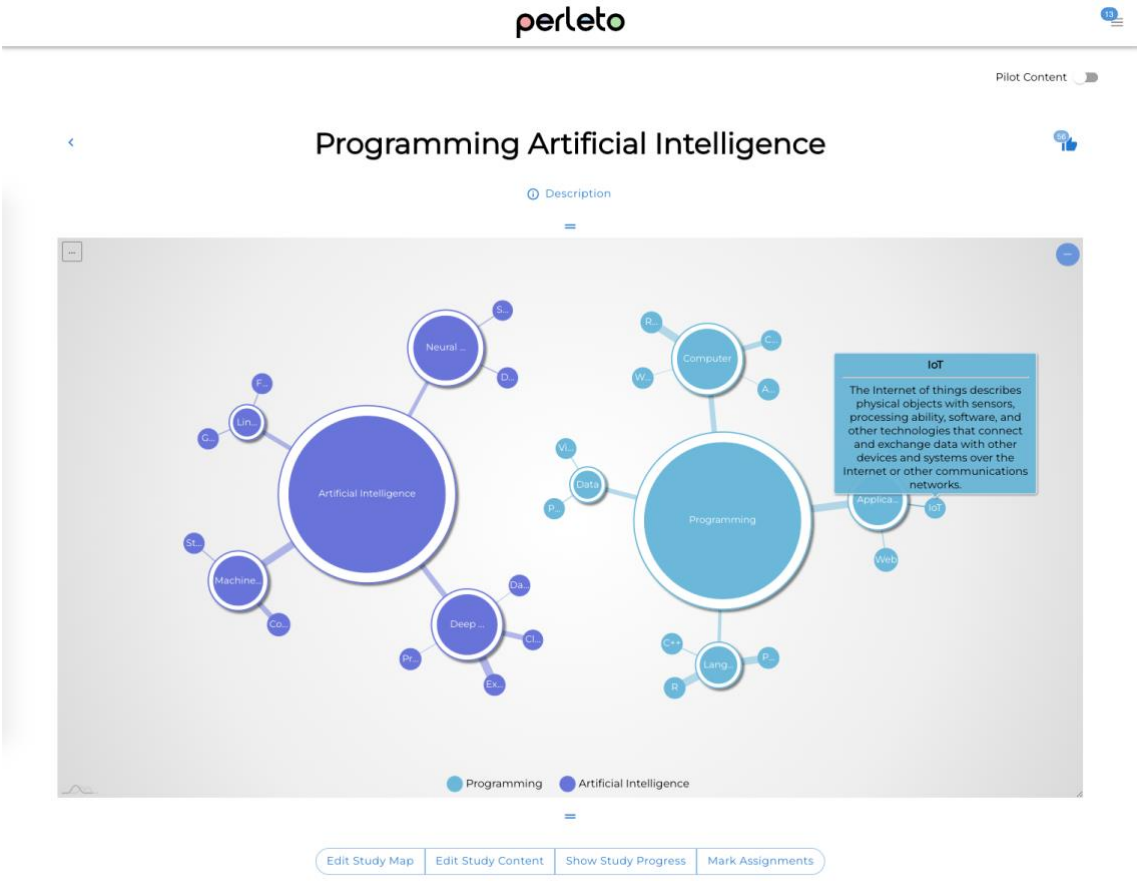

Figure 32: Prototype Content editing

The content creator has successfully had their content created with the assistance of Artificial Intelligence. Simple heading and navigation is available, with the content title, backwards navigation, amount of likes and the description which can be toggled to be visible and hidden to reduce clutter. Additionally, a “Pilot Content” toggle switch and a drag handle, both which will be covered later in this paper.

There is a Force-Directed Tree (created with AmCharts component library), which is populated by the skill keywords and their values. The values represent strength and relevance between related skills. If the node is larger, it is more relevant and the connecting line’s size represents the strength of the relation to the connecting node. The author felt the idea of relevancy and strength would be much better suited to being a Force-Directed Tree rather than a Wordcloud. It is much easier to process the information provided with the smoothened edges of a circle, rather than an entropic cluster of words.

The user is able to interact with the Force-Directed Tree by dragging, zooming, toggling and hovering. Once the user hovers over the node, the description is displayed as a means to begin the interactive studies. If the name of the node is too long to be displayed, it will be partially displayed followed by "…" ellipsis overflow.

Another criteria that is possible via the Force-Directed Tree is to be able to download data in numerous formats. JSON, .jpeg, .png, though most importantly, .pdf. The client had requested that the student could be able to download a certificate that would be possible to be read by another project's (CareerBot) Document Parser to populate the skills and competencies gained in the process of studying their NanoCompetencies. The author was able to configure AmCharts to display the pdf document with the logo, visualisation and key skill words in their relevant categories. Headai's Document Parser is able to process these documents.

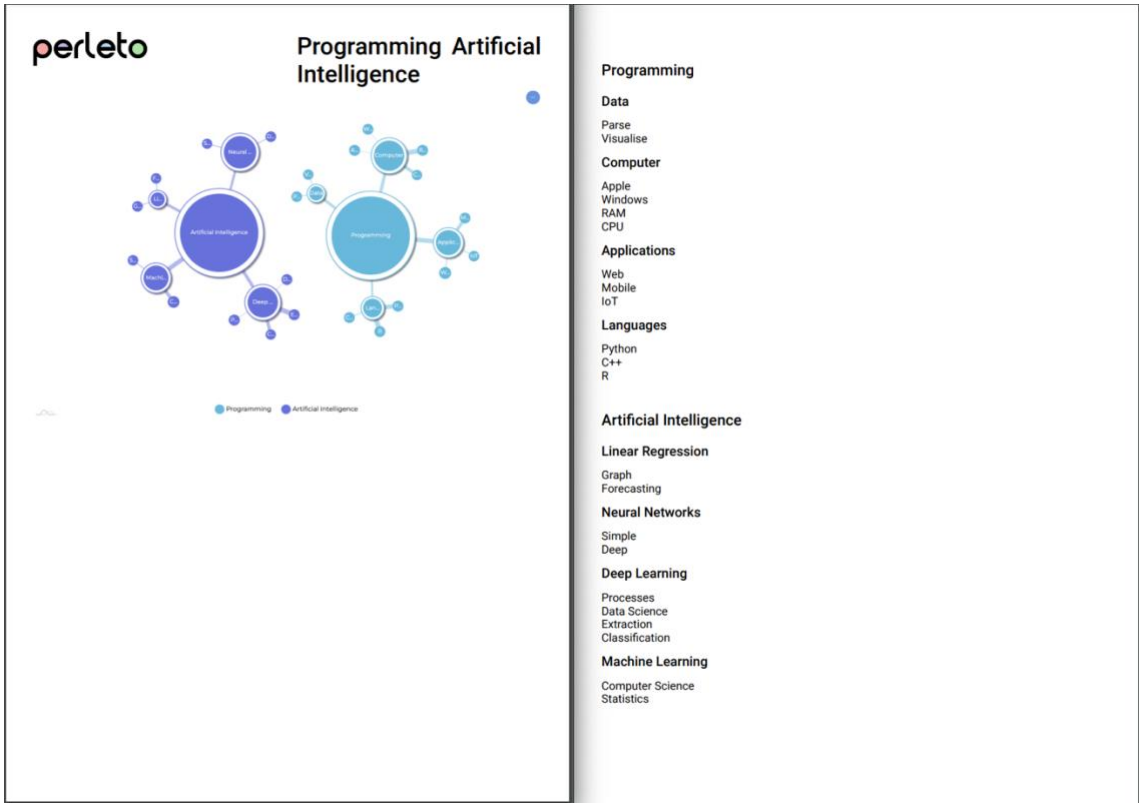

Figure 33: Prototype Study certificate pdf

Following on from the visualisation, there is a button group displayed to enable the content creator to navigate to relevant fields: Study map editing, assignment creation / editing, student progress and assignment grading.

6.6 Visualisation editing

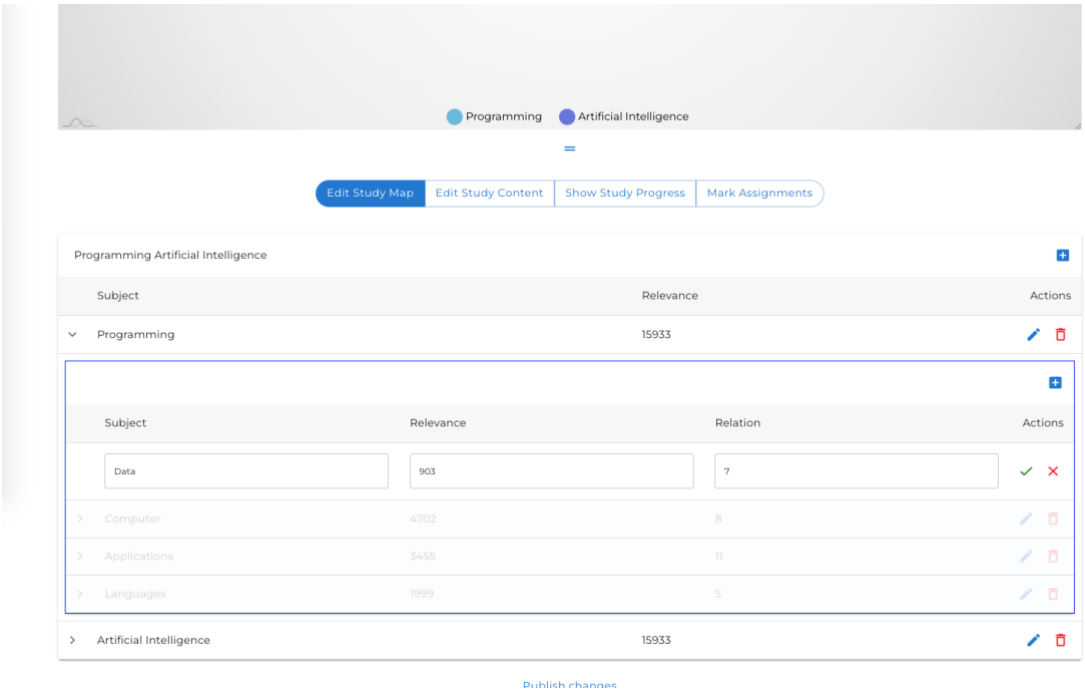

Figure 34: Prototype Visualisation editing

Flexibility and freedom were an important aspect in the opinion of the author. The purpose of being called a personalised learning tool also implies that things should be customisable. If the Artificial Intelligence has populated the content from text, perhaps the content creator had forgotten to add certain important skill keywords, this must be editable. Displayed above is the table for editing the names of the skill keyword, relevancy and strength.

MaterialTable was used for this table component, as MaterialUI (and many other) offer similar solutions. Visually, MaterialTable felt easier to understand as it is laid out more spaciously than an excel style spreadsheet style of data grid. The content creator can freely add, delete and edit almost everything displayed on the Force-Directed Tree.

Once the content creator is pleased that their content has met their expectations, they must click the “Publish changes” button to save their content to the Firestore database.

6.7 Study material editing

A proposed solution to make the process simpler for the content creator was to utilise another of Headai’s services. Fast Degree offers Aritifical Intelligence gathered study materials: Articles, videos for example. These materials could be generated by the Artificial Intelligence, then reviewed and edited by the content creator.

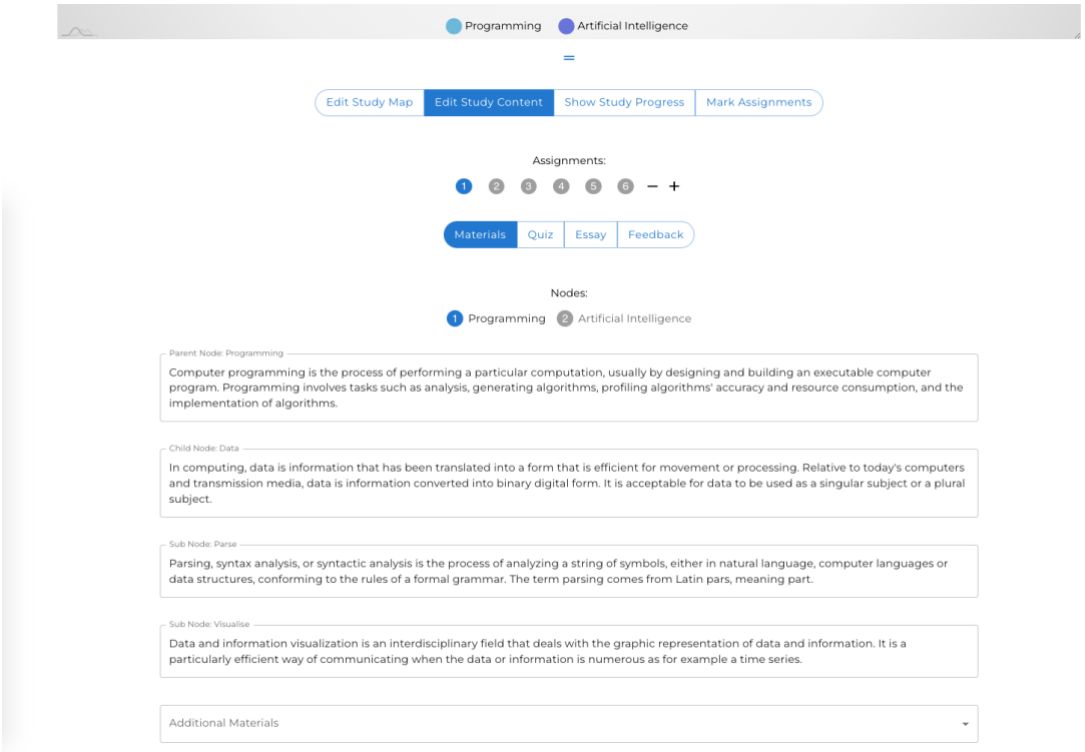

Figure 35: Prototype Study material editing

The area begins with MaterialUI's Stepper component, as from the author's experience with eLearning platforms during their studies at Laurea have shared a common theme, that courses are divided in assignment steps. The content creator is able to add new assignments via the plus icon and delete via the minus (if there are more than one assignments).

The assignments consist of: study materials, quizzes, written assignments and feedback for the content creator about the assignment that they have just completed.

Study materials are divided by another Stepper which divides the materials into the categories of the parent nodes. Study materials consist of the descriptions of the nodes, so the student can get familiar with the fundamentals of the skill keyword's topic. A video is possible to embed. Images are possible to upload and are converted to Base64 image encoding. A link with the browser icon, scrubbed address (display as a clickable link as www.*address*.com) and will open in another tab to deepen the student's knowledge. Once the content creator is happy with their changes, similarly they will publish the changes to Firestore via the button at the bottom of the page.

Quizzes exist in all shapes and formats, the client had requested that the author look into Typeform. Typeform offer flexible interactive quizzes that are modern and used widely in gathering information for businesses. The author had found that a Typeform component library is available for integration in ReactJS, however the content creator then would have

to navigate to Typeform to create their quizzes. In the author's opinion, it made little sense to offer a service that is dependent on their users navigating elsewhere and then potentially negate the purpose of the Data visualisation.

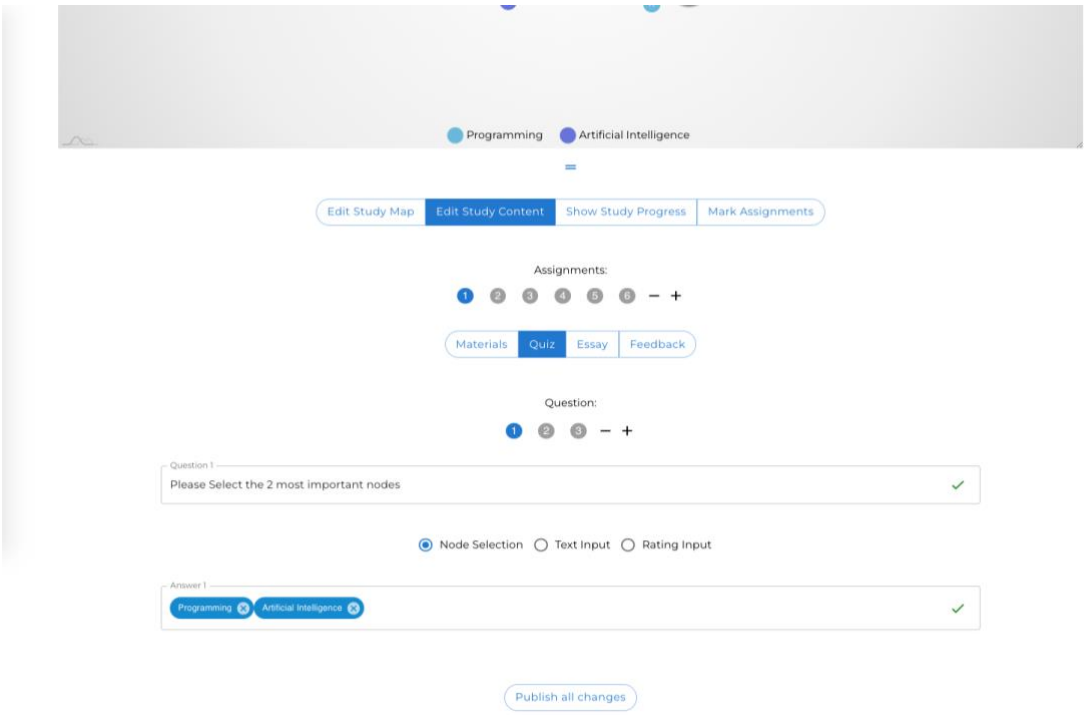

Figure 36: Prototype Quiz editing

The author took inspiration from Typeform's quiz style that answering questions is dynamic. Sometimes the user must select from multiple choice, give a rating with animated stars, text input. To keep the interactivity connected to the Data visualisation, one way that a student would answer the quiz questions, would be to select the nodes on the graph. The nodes are loaded into MaterialUI's Chip component and can be easily removed via the x button contained in the Chip. An advantage of the node selection to answer the questions, is that the risk of typing errors causing false negative results has been greatly reduced. Additionally, for the flexibility and dynamics of learning content, written answers are available, as are rating questions.

The written assignments and ratings similarly have a stepper component to condense and reduce visual clutter. The content creator is able to set the topic in the text field.

All of the quizzes, written assignments and ratings can be easily added or deleted, much like for the assignments. If the content creator for example only wanted five quiz questions, one written assignment and two rating questions, this is all possible and customised throughout each individual assignment. Similarly, once the content creator is satisfied, they will press the button at the end of the page to publish the changes to Firestore.

Now that the content has been created, it is equally important for the content creator to be able to experience what they have just made. Without experiencing through the student's eyes, there could be typing errors, incorrect answers to the quizzes to name a few things that could accidentally degrade the quality of the NanoCompetency. The author felt it to be most important for the content creator to be able to test and adjust accordingly, easily. A "Pilot content" toggle button is at the top of every page, if the author of the content's unique identity code matches the code registered in Firestore.

6.8 Studying / Piloting

To begin with, the idea is for the student to begin to become familiar with the concepts displayed on the Force-Directed Tree. However, flexibility is important. The descriptions and study materials are available for piloting or studying in the button group.

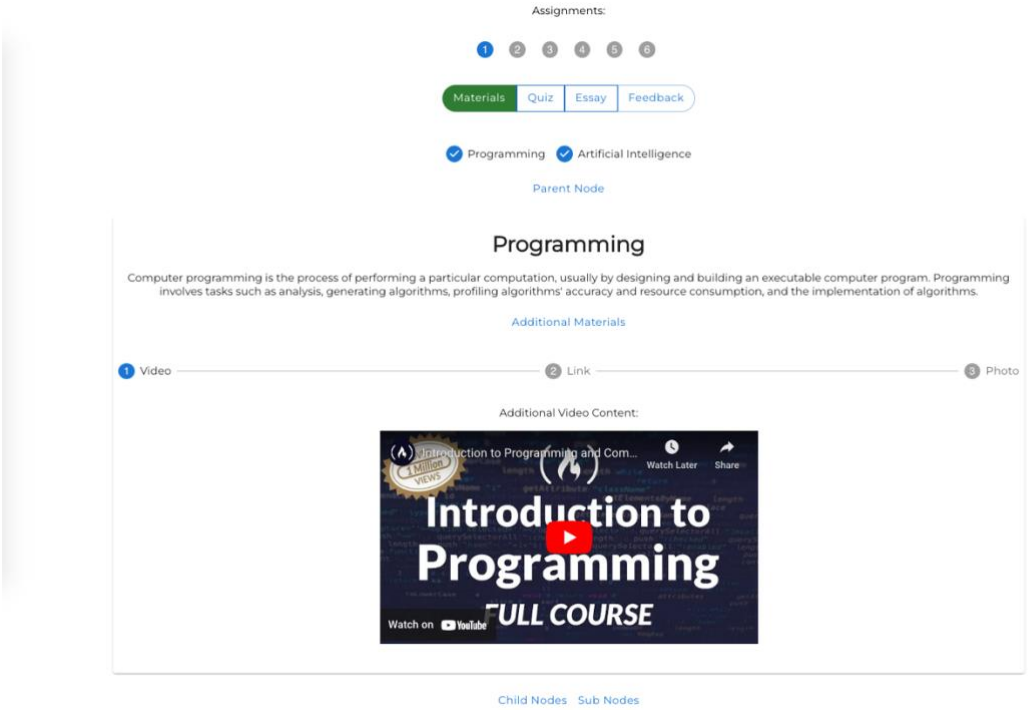

Figure 37: Prototype Additional materials

The provided materials are split into the parent node categories, then materials loaded onto Card components. It is possible to toggle the visibilities of the additional materials and card groups (Parent, Child and Sub). Additional materials are available via the stepper, if the content creator has chosen to upload these materials to assist the learning process.

Once the student has completed reviewing the materials, they are able to click a button at the bottom of the page to verify that they have completed this task. The idea here is to enable the student and content creator to easily see the progress on the button groups and

steppers. As in the above image, the study materials have been completed, the parent node steps have blue ticks instead of numerical values and the button group for materials has now turned green.

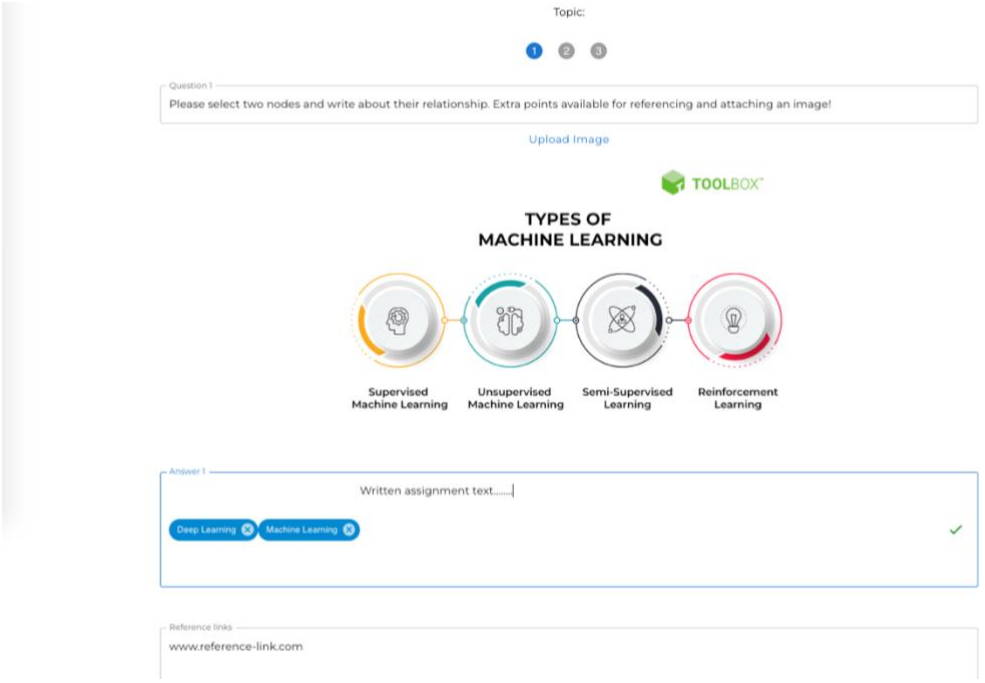

Figure 38: Prototype Written assignment

The written assignments enable the student to upload an image to support their written work, attach links and write their essay or short written assignment. Node selection is also possible, to enable maximum flexibility for the content creator and make a more dynamic experience for the student.

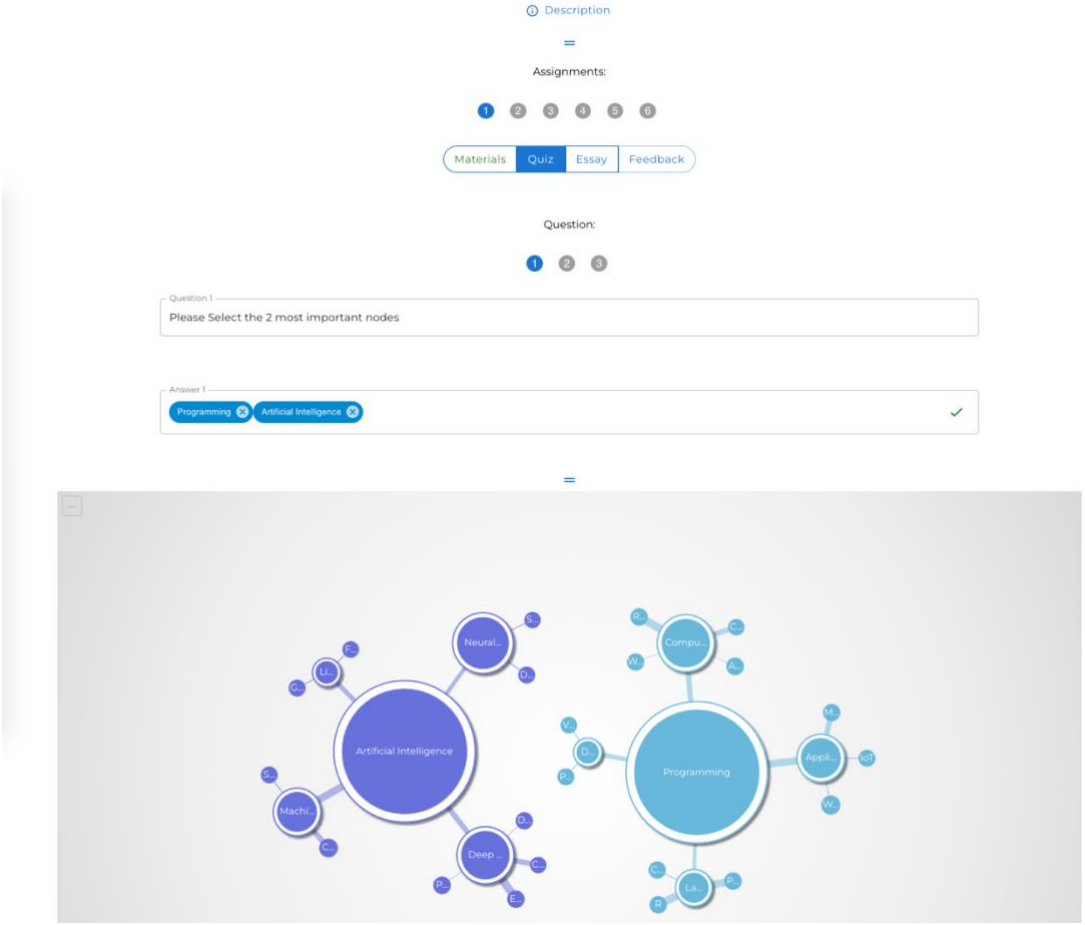

Figure 39: Prototype Window configuration

As the quiz component shares identical styling, this will not be covered. However, the author and client were both of the same opinion, that some of the functionality feels more natural if the Force-Directed Tree and Assignments / Editing workspaces could be adjusted. ReactBeautifulDnD component library offers a solution to this problem. The users are able to grab the two horizontal blue lines and adjust the workspace to their comfort. Quizzes were one of the main areas where the author and client felt it was more natural to read, then look down for the appropriate reference point, then answer. That being said, the written assignments felt more natural to look up at the Force-Directed Tree for reference.

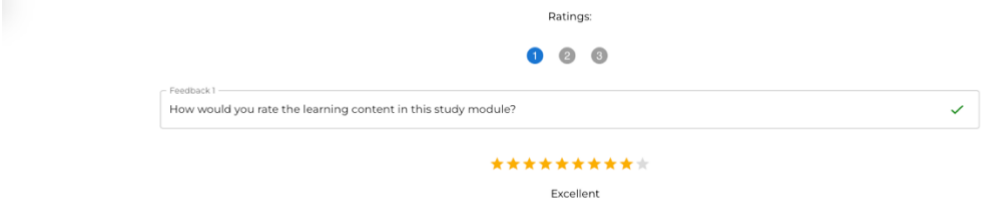

Figure 40: Prototype Rating assignment

Finally, the student comes to the end of this assignment and begins to give feedback via animated Star Icons. On hover, the star is larger and when not selected, it displays as grey. A rating text is displayed below, ranging from useless to excellent.

6.8.1 Study Progress

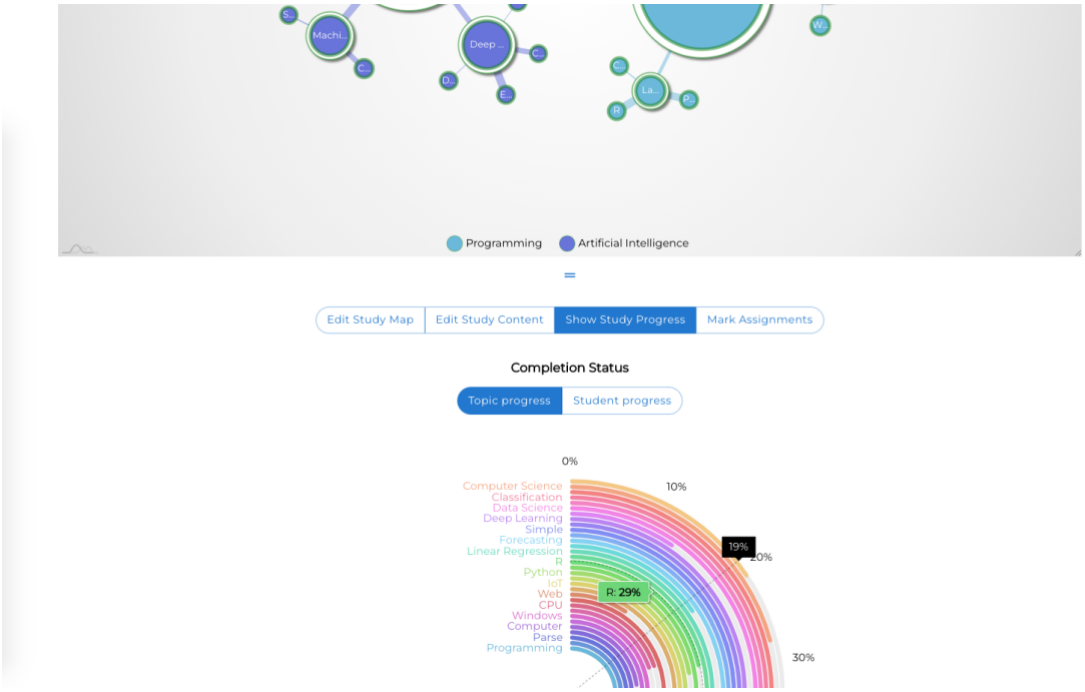

Figure 41: Prototype Study progress

For the content creator and student, it is important to have visual feedback on the progression which has been made in their studies. As with the Throwaway Prototype, the traffic light progression system would be an easy way to see that most nodes are green, yet some remain yellow or red during the study implementation. This feedback could enable the content creator to realise that perhaps the study content is too difficult for the students. Additionally, it would be very useful for the content creator to be able to see the progression in the assignments and how far the students are managing to get in the set assignments.

6.9 Community discussion

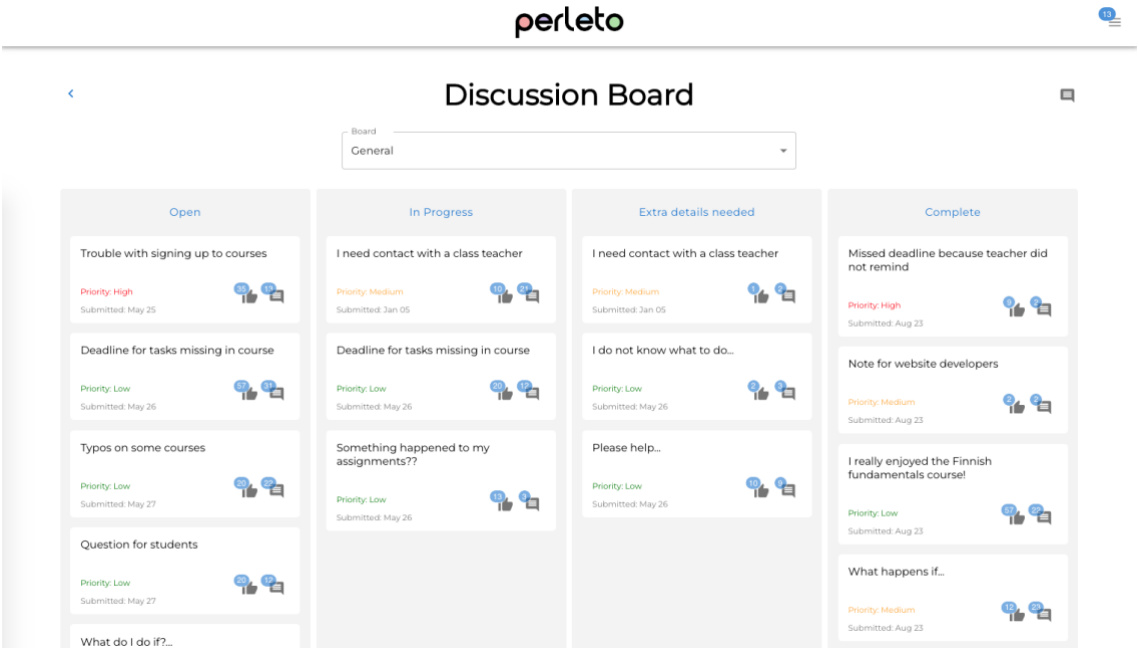

Figure 42: Prototype Community discussion

A discussion board has been implemented utilising ReactBeautifulDnD component library. The board has been heavily inspired by the platform Trello, wherein there are cards which contain a topic, description, attachments, likes and comments. The author and client are of the opinion that the Kanban style boards (drag and droppable card system, heavily inspired by specifically Trello) would bring an easy project management style feel to the community discussions. The idea is to have a general tab for overall platform questions or problem reporting, then to have individual boards where the students and content creator can discuss in a community about the materials or any queries in general. Once the matter has been posted, it would be in the “Open” section, then draggable to “In Progress”, “Extra Details Needed” and then final “Complete”. Each card would be assigned priorities from Low to High.

6.10 Notifications

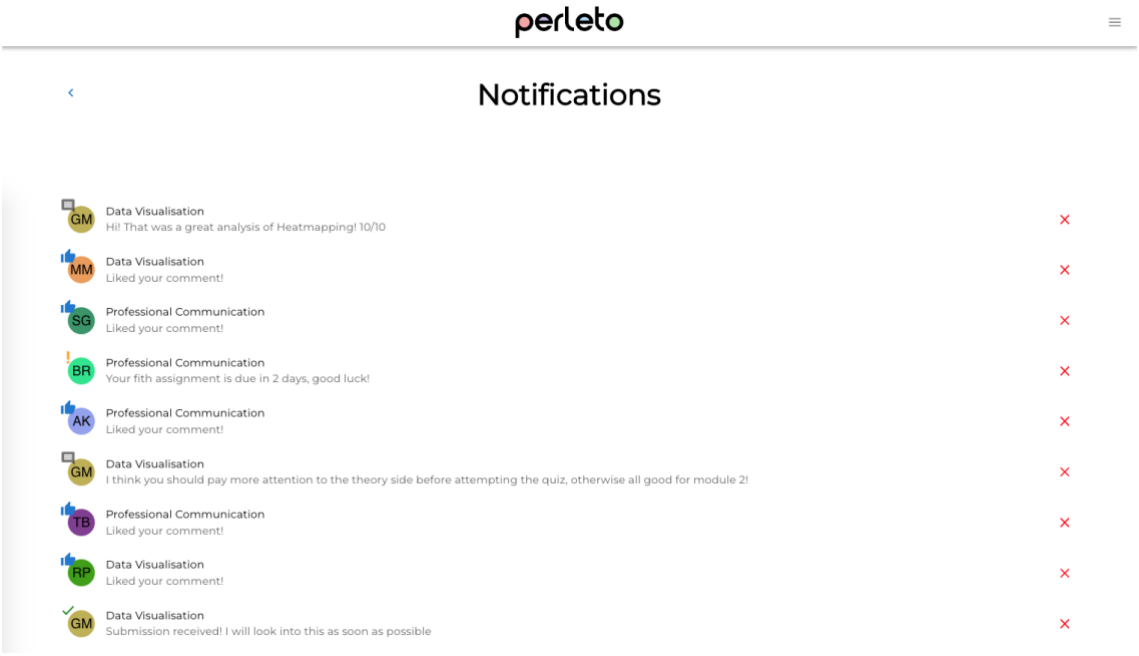

Figure 43: Prototype Notifications

In previous steps, a notifications Badge displaying a number have been visible from the menu. Once the user lands on the notifications page, the Badge will disappear, then the user can manage their notifications by reading and removing them if necessary. Notifications would be a necessary component for allowing content creators to remind their students to complete their assignments before a deadline, view likes, comments and progress of their “ticket” in the community discussion area.

The notifications list displays the user in their Avatar, the badge signifies what kind of notification it is, then the title being where the notification has come from and the content of the message of the notification, whether it would be a like from their “ticket on the community discussion board or feedback from the content creator about a completed assignment and more.

7 Prototype next developments

There are necessary next steps to take the Extreme Prototype to be closer to a true product. Whilst working on the Extreme Prototype, the author always began working with static data sets, until the necessary components would be functioning as expected, only then would it make sense integrate the functionality to Firebase and Firestore. The following areas will be looked into in the next steps of development:

Home page: the home page will require more tailored information and images following on from the interactive articles background. Perhaps a Footer Navigation bar would be useful, however the author has attempted to keep the content in as much of a one screen's worth of content by dividing sections in to smaller chunks, to experiment more with the Z Layout.

Onboarding: The onboarding is lacking the amount of help content that it should have to be helpful to all users. The onboarding would also be a crucial step to understanding who might be a student and who has the privileges to create content and who to only study.

List of NanoCompetenices: In the event that there would be tens or even hundreds of NanoCompetencies, the current list would not be sufficient. A Search bar would be ideal, wherein the TextToKeywords would enable the user to search via the skill keywords, category or simply just by the name of the NanoCompetency. Filtering would make the experience easier, whether it be the newest NanoCompetencies, most liked, from a certain content creator or from the top 5 content creators.

Content Workspace: As the user can drag and drop their workspace to their preferred arrangement in a vertical manner, the author feels that it would also be a nice feature for those with wider screens to be able to have their workspace displayed in horizontal manner if they so choose to.

Data visualisations: The author has considered the idea that the content creator could be able to change the visualisation to a Packed Circle Chart, Bubble Chart or which ever visualisation that represents relations might suit the content creator's vision for the learning materials.

Content Assignments: The styling is rather rudimentary at this moment, as the author was focusing more on the logic. The assignments created by the content author are stored and called from Firestore, however the student's work is not. Furthermore, the student's answers are not yet graded. In the actual event of implementation, the author and client would wish for the Artificial Intelligence to grade the written assignments and enable the content creator to moderate. For each assignment, it would be ideal to enable the content creator to either create a new Force-Directed Tree or simply just focus certain assignments on a particular Parent node and to be able to have customised descriptions and additional materials per

assignment. The author would also wish to experiment with various other interactive quiz tasks than the current 3 options. Boosting a sense of community would be a nice feature to implement, having peer reviews on written assignment would be a very nice feature to implement. Various bug fixes necessary.

Study progression and grading: No grading has yet been implemented yet for the content creator to moderate. Study progressions are limited to static data for the moment as the priority was not as high to complete before the assignments are editable and the students can submit their works. Once these steps have completed, the author would like to review different approaches on the most appropriate visuals for the content creator and students. The author has explored various opinion polls and has begun to form good ideas on the visual feedback for the students in their quizzes, for example that the student could then view on a bar graph with percentages. The student's own answer vs what others have answered, anonymously and give the student feedback and encouragement on their answer or guidance to study the relevant materials in finer detail.

Community discussion board: This has only been configured as a possible feature to integrate, hence there is only static data, which does not change when selecting from the dropdown menu another board. Comments likes and new posts would also need to be integrated. Firestore functionality would then be the final integration for the discussion board.

Notifications: The notifications board is also currently only a static data set, as once again the priority has been considerably lower than other tasks. The client initially outlined one important feature which aligns with notifications, reminding students via email or text message that a deadline is coming up. The author is aware that Firebase offers both SMS and email functionalities.

General: Further testing is required to locate bugs, features, styling errors and how to best fix these. Cross browser and mobile support must be critically tested once the functionality has been fully implemented.

Language support: There are language component libraries which could be implemented at very last, if the stakeholders would wish to have the platform also available in Finnish or any desired language.

8 Conclusions

The author has learnt many valuable skills throughout the independent research and implementation. Whilst there have been setbacks in primarily ability, followed by time constraints for such a large task. The author feels confident that they have managed to find professionalism from the extreme learning curve. The author still has much to learn, however looking back at the beginnings of this project, the author was unconfident and lacking ability in working with ReactJS, efficiently working with API and creating data sets. Now, the author has had a lot of experience to carry on into working life, with a working prototype to boost employability prospects and continue to self-develop their own skills and competencies.

The client throughout the process that began in the early - mid 2022, has always been very encouraging, supportive and has been excited to see new developments and results. The client has decided that the prototype is mature enough to discuss funding sources for the final stage, implementation. Additionally, the author and client will be pitching the prototype to additional external shareholders and discuss building a team for the implementation stage.

The author will continue to develop Perleto.

Perleto is available via:
https://perleto.vercel.app/

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