CTE Website

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Abstract

The Computational Tissue Engineering program at Virginia Tech is an interdisciplinary program that allows graduate students to learn about the following fields: Tissue Engineering, Computational Science, and Molecular and Cell Biology. The vision of the CTE program is for students to feel better equipped about these disciplines and act as trained professionals who can both develop and help push the boundaries of these disciplines.

The current CTE website was created a decade ago with a software system called Basecamp by our client Dr. Murali. Throughout the years, it was established that the CTE website became more difficult to update due to newer releases and versions of Basecamp and PHP. Our goal for this project was to update the current CTE website to a modern framework that would allow for an easier to update interface.

Our methodology to update the current CTE website started with choosing a web development system that would best fit the needs and requirements of this CTE website. The capabilities of WordPress and additive functionalities led us to choose WordPress as our web development system.

Our methodology to update Dr. Murali’s research website involved understanding the layout and overview of how the website currently looks, researching the UI of other research websites, and creating the research website on WordPress.

The outlined project deliverables involved understanding the pros and cons of choosing a web development system that would leverage the capabilities of easier maintenance with a refined layout, implementing a bare bones CTE website, and implementing additional features including building Dr. Murali’s research website.

Throughout the project, group members worked together to understand the front-end and back-end aspects of the project including researching specific plugins to use that would best fit the feasibility of the website, building of Figma wireframes, form creation, migration of past CTE website pages to the new CTE website, and testing both the functionalities of the CTE website and Dr. Murali’s research website.
**Introduction**

Low-code and No-code platforms are becoming more prevalent and increasingly popular because of their ability to reach a wider audience of both technical and non-technical employees [1]. These platforms garner individuals to leverage the capabilities and functionalities of the features that the platform can provide through form creation, incident management, customization and tailoring of specific features to fit client needs, etc.

Our project utilizes WordPress [2], a low-code platform that allows for website development. Since the prior website utilized Basecamp and PHP [3] code that was hard to maintain, our project focused on developing a website that would be easy for Dr. Murali to update and maintain for individuals involved in CTE [4]. This project explores the functionalities within WordPress and our utilization of plugins [5].
System Requirements

Maintenance:
- The website should be easy to navigate for a variety of users. It should support users that may have little to no experience with coding, and who assume roles including: subscriber, contributor, author, editor, and administrator.

Admin Privileges:
- The admins should be able to quickly specify user privileges such as changing a user’s role from a contributor to administrator, depending on tasks assigned to a specific user.
- An admin should have the ability to add and modify forms for the website as necessary.
- An admin should receive first priority when it comes to upgrading plug-in features for specific tasks.

Automation Components:
- The form results on the website should map to specific entries. These entries can pull from results on any page. For example, if a page contains form results from adding a CTE student such as name and year recruited, these fields should be able to easily pull from the saved form database results.
- The website should be automatically updated for each form submission.
**Design**

To start off this project, Dr. Murali suggested that we wireframe the pages of the current CTE website and his research website to provide insight into the interactions among the pages. This would help us understand how the revamped version might be formatted.

The default landing page shown in Figure 1 helped us structure the landing page of the updated website.

![Figure 1: Default Landing Page](image.png)
Figure 2 is an example of a static page, which helped us construct our bare bones implementation of the CTE website.
Figure 3 represents a specific page on the website that can change the current students’ part of the CTE program over time, so recognizing how quickly it would be to add or remove students from the current students page was a task that our group had looked into. Since the information on dynamic pages could change based on the user updating the website, it was important to consider what plug-ins were necessary to update this information and how form creation led to this update. The plug-ins that we considered for form creation are the Contact Form 7 [6], Post My CF7 Form [7], and WP Forms [8]. Contact Form 7 allows for the creation and management of multiple contact forms, while Post My CF7 Form extends this capability by mapping form submissions to custom posts, thus enabling easy updates to dynamic pages like the current students section of the CTE program. WP Forms simplifies form creation with a drag-and-drop interface, making it easy for non-technical administrators to keep website content both current and reflective of changes within the program.

![Current Students Dynamic Page](image)

**Figure 3:** Current Students Dynamic Page

The research project spotlight page shown in Figure 4 contains a description of a specific research project. The spotlight feature should be able to have the functionality to randomly select
a research project from a list of research projects. This is similar to the functionality of both the Faculty and Alumni Spotlight pages.

**Figure 4:** Research Project Spotlight Page
The past news and events page has a similar format to that of the prior CTE website -- with the news title, date, and author listed as shown in Figure 5.

All of the frames follow the same structure and interactions of the prior CTE website. This is to ensure that the functionalities are the same, but if a change were to be made it would be easier to do so on WordPress.

**Figure 5: Past News and Events Page**
Similarly, for Dr. Murali’s research website we designed a layout that built off the features of the previous research website, as shown in Figure 6.

The sidebar is placed at the top of the page with all the information migrated from the previous website to the new one.

Figure 6: Wire Frame for Murali’s Research Website Home Page
Deliverables

For the development of the CTE website, we leveraged the extensive capabilities of WordPress to ensure a modern, efficient, and easily usable website. WordPress, known for its flexibility and no-code/low code software, served as the foundation for both the CTE and research websites, enabling us to create a robust platform tailored to the specific needs of our client, Dr. Murali.

CTE Website Development

WordPress as the Development Framework
The decision to use WordPress was driven by its wide range of features, including a vast repository of plugins and themes to choose from. This allows for the creation of dynamic websites that can be easily updated and managed, addressing the challenges faced with the previous system.

Website Structure and Design
The website features a series of static pages that form the core content of the site, such as About CTE, People, Research, etc. These pages are designed to provide essential information about the CTE program in a clear and accessible manner.

Customizable Menus
We created customizable menus that will enhance site navigation, making it easier for users to find the information they need. This was achieved through intuitive placement and logical organization of menu items, which will improve the user experience.

Forms for Content Management
A significant feature of the CTE website is the implementation of forms. These forms were designed for use by website maintainers to update student information on the site. Once filled in, these forms automate the process of updating the students’ pages, thereby streamlining website maintenance and ensuring that the site remains current with accurate information. This functionality is crucial for the CTE program, as it allows for real-time updates of student achievements.

Research Website Development
For Dr. Murali’s research website, our approach centered on improving readability and formatting to ensure ease of access to specific information on the website. This involved a thorough analysis of the current site layout and the UI of other leading research websites to gather insights into best practices in design and navigation. The goal was to create a platform that is not only aesthetically pleasing but also facilitates easy access to research materials, publications, and project information.

WordPress Calls For Interactive UI, User Accessibility, and User Engagement
Both the CTE website and research website were developed using WordPress. This CMS has a variety of plugins which allowed us to add certain functionalities that our project required. The main focus of the project was to create a bare bones CTE website that has the functionality to be easily accessible and updated with the ability for form management integration, enhancing CSS elements for better user interface design, and updating Dr. Murali's research website.

**WordPress Plugins**

To enhance the functionality and user experience of Dr. Murali's CTE research website and his personal research website, we needed to use specific WordPress plugins, discussed below. These plugins are pieces of software that can be added to the websites to extend functionalities or add new features.

**Elementor**

This drag-and-drop page builder simplifies website design, allowing for the easy addition of content, author bios, comments, and more. Its variety of templates facilitates the creation of a visually appealing and organized site, essential for showcasing Dr. Murali's research findings and academic contributions [9].

**Elementor Custom Skin**

This plugin complements Elementor by offering dynamic templates and conditional logic, enabling the creation of a responsive and interactive website. Custom designs can be triggered by user actions, providing a tailored browsing experience that highlights Dr. Murali's research effectively [10].

**Custom Post Type UI**

By enabling the creation of custom post types and taxonomies, this plugin allows for the categorization of content based on specific research topics or types, such as publications, projects, or studies. This plugin will enhance site navigation and help users find relevant information more efficiently [11].

**PublishPress Authors and Capabilities**

These plugins offer refined control over user roles and permissions, ensuring that multiple contributors can collaborate on the website while maintaining the security of the content. This is especially beneficial for both research websites since they involve contributions from various researchers and scholars [12].

**Contact Form 7 and Post My CF7**

The Contact Form 7 and Post My CF7 plugins streamline the process of collecting and managing inquiries or submissions through the website. Contact Form 7 allows for the easy creation of customizable forms, while the Post My CF7 plugin enables the mapping of CF7 forms to
customized posts. Both these functionalities will allow maintainers of the CTE website to simply submit student information which will thereby automatically update the student pages.

**WP Forms**
WP Forms is a form building plugin that contains drag and drop functionality. There are many templates available that can be customized based on specified requirements. There are options to create survey forms, add customized HTML blocks, and integrate with applications such as: MailChimp, Google Sheets, etc. This plugin will allow users to enable mapping between form responses and specific pages on the WordPress website.
Testing

In order to test usability, we should poll representatives from different user classes that will interact with the websites. As the main client of the websites, it is important that Dr. Murali can easily edit each website in a way that uses little to no code. Once the features of each of the websites are implemented, we tested their usability by analyzing how intuitive they are for Dr. Murali to use. It is important that students interested in CTE and Dr. Murali’s research are able to easily navigate the websites.
Developer’s Manual

The current site architecture for the CTE Website is shown in Figure 7.

Figure 7: CTE Site Architecture

The current site architecture for Dr. Murali’s Research Website is shown in Figure 8.

Figure 8: Research Site Architecture

Accessing the WordPress Developer Site

- To access the WordPress Developer site, the user must first log into WordPress via Virginia Tech’s Computer Science site [13].
- After logging into Virginia Tech’s Computer Science site, the user can access the WordPress dashboard listing the sites they have access to.
- The user can access many tools such as plugins to create or edit the WordPress sites based on the user permissions they have.
- The most important tools related to the CTE and Research websites are the following. Figure 9 shows the needed tools located at the WordPress Task Bar:
  - **Pages:** Used to access the current pages used for the website.
  - **Appearance:** Used to edit the pages of the website.
  - **Plugins:** Used to add, remove, and access tools provided from plugins.
  - **Users:** Used to access other developers who have access to the WordPress page.
  - **Media:** Used to access images that are used throughout the website.
Figure 9: WordPress Task Bar
Users Manual

The most basic feature of the CTE website representative of a bare bones version is the implementation of the current static pages on the original website. Examples from the new CTE website include the 'About CTE' and 'Education & Training' sections. A comparison of the old and new versions of the About Page can be made by considering Figure 10 and Figure 11.

Figure 10: Old About CTE Page

Figure 11: New About CTE Page

The current implementations of the static pages mimic the information provided in the current CTE website. The website features a top navigation bar that enables users to easily browse through the site and access various pages. Additionally, the navigation bar includes dropdown menus that link to related pages or sub-pages associated with the main sections of the site. Some pages contain images, as well as important links that redirect users to Virginia Tech’s resources and other related programs. At the bottom of the page, there is also another navigation area to traverse the site.

Use Cases / Tasks Supported

- Use cases:
  - For potential students or faculty members interested in the website
  - For users who are interested in learning about the CTE program at Virginia Tech
- Tasks Supported:
  - Traversal throughout the website on static pages
  - Traversal throughout the website for dynamic pages (including form to page updating)
As illustrated in Figure 12, each page features a navigation menu positioned at the top. Clicking on an option without a dropdown arrow directs the user to that particular page. Conversely, clicking on an option with a dropdown arrow provides access to a list of subcategories for the corresponding section.

Figure 12 also shows the sidebar menu that is found on every page. The search menu allows the user to search for any page/post with a given keyword/keywords. The options under the search bar would ideally contain subcategories for the section of the current page, but for now it only contains the posts from each month.

The home page contains an image carousel (shown in Figure 12) that cycles through three different images. The captions on the images have questions related to the CTE program that quickly give the user an idea of what the program does. Clicking any of the three images takes the user to the “Research Opportunities” page. The carousel cycles between the images automatically, moving to the next once about every 5 seconds, but the user can also move to the next image by either clicking one of the arrows on the left/right or manually sliding the image left/right.

**Figure 12:** Home Page Image Carousel/Navigation Menu
Figure 13 displays the CTE Interest Form. Students interested in joining the program can use this form to submit their information to Dr. Murali and the website administrators.

**Figure 13: CTE Interest Form**

Upon submission, a draft of a post will be created and added to the list of posts in the dashboard. If an administrator seeks to review a list of student page drafts, they can simply click "Draft" at the top of the page to easily locate them as shown in Figure 14.

**Figure 14: Admin Page**

As shown in Figure 15, an administrator is prepared to add a student's page to the website, they simply need to click "Quick Edit", select "People" and "Current Students" while deselecting "Uncategorized". Subsequently, the status should be changed from "Draft" to "Scheduled". Despite the terminology, this action publishes the post immediately once the administrator clicks "Update".
Figure 15: Editable Drafts Page

Publishing the post automatically places it on the "Current Students" page, where it is inserted in alphabetical order by first name. Figure 16 highlights the Current Students page, which dynamically incorporates data from the CTE Interest Form. As students submit their interest forms, their information is automatically mapped and displayed on this page, providing a comprehensive list of all students currently enrolled in the program. This seamless integration ensures that the page remains up-to-date with the latest student entries.

Figure 16: Current Students Results Page
Figure 17 showcases an example of a personal post for a specific student, derived from the Current Students page results. This post provides a detailed profile of the student, including their academic and extracurricular accomplishments within the program. When viewers click on the "Read More" option, they are redirected to this detailed personal page, offering a closer look at the student's contributions and experiences in the program. This feature allows for a more personalized engagement with individual student stories.

Figure 17: Individual Student’s Page

An administrator seeking to efficiently access a list of student pages may select "Current Students" from the "All Categories" dropdown menu at the top of the interface, followed by pressing "Filter" as shown in Figure 18. Should an administrator wish to publish multiple student page drafts simultaneously, they can select the checkbox to the left of each draft they intend to publish. Alternatively, if they wish to select all posts at once, they may click the checkbox at the top left corner.

Figure 18: Publishing Multiple Student Pages
To add or remove an input in one of the forms, users may select the "Contact" tab from the dashboard menu and then click on the name of the desired form as shown in Figure 19. Subsequently, the "Form" tab provides the functionality to add or remove a label that corresponds to an input in the form. Blocks to add a form tag for each input type are conveniently located at the top of the tab.

Adding an asterisk (*) next to the declaration of an input type designates that field as required. Although not currently implemented, it is possible to configure the system to send all responses from a certain form to a specified email address via the "Mail" tab.

Figure 19: Backend for Forms
The "Form to Post" tab, shown by Figure 20, enables users to map any input (utilizing its "Name" from the form tag) to a corresponding field. Generally, it is recommended to assign the name to the "Post Title" field, the "About" section to the "Post Content" field, the program description to the "Post Excerpt" field, and any provided image to the "Featured Image" field. It is important to note that the "Featured Image" field can only be associated with an image-type field, while the other default fields should be matched exclusively with text-based types.

![Figure 20: Form to Post UI](image)

Figure 20: Form to Post UI

Figure 21 illustrates how a user can create custom fields in the "Map form fields to post meta-fields" section to accommodate inputs that do not correspond with one of the default fields. To establish each custom field, one should click on the blue circle featuring a plus sign, select "Custom field" from the "Select a field" menu, enter a meta key in the subsequent text box, and choose the appropriate form field from the "Select a form field" menu. Custom fields can be deleted by clicking the red circle with a minus sign located next to them.

![Figure 21: Map Form Fields](image)
Figure 22 shows the search bar at the side of the page that allows for the user to search specific keywords, and provides the results to the user. All of the posts and pages where the keywords are found are displayed to the user.

![Search Bar](image)

**Figure 22: Search Bar**

**Advanced Custom Fields**

Based on Figure 23, each custom field should correspond to its own ACF field. The Current Students, Alumni, and Faculty categories all have their own field groups. To edit one of these field groups, select the “ACF” tab in the dashboard menu and click the name of the desired field group. In this tab, there is also an option to create a new form group if desired.

![Field Groups](image)

**Figure 23: Field Groups**
To add a new field, simply click the “Add field” button indicated by Figure 24. Any ACF field that maps to a custom form field must have the same value in the “Field Name” box as the meta key of the associated custom field. To edit an existing field, click its dropdown arrow and update all desired inputs. To delete a field, simply click “Delete.” Once all desired changes are made, click “Save Changes.”

![Figure 24: Adding Fields](image)

The only exceptions to this rule are if a user desires a person’s page to display information that does not correspond to an input from the form (such as “Year Recruited” in the Student Interest form) or if a user wishes for another user to submit information in a public form that is not displayed on their page (such as their email address).

To display information from a field that does not have an input in the connected form, a user can create an ACF (Advanced Custom Fields) field for this information without creating an associated custom field in the form as shown in Figure 25. Conversely, to receive information from a form without displaying it on the page, a user can create an input for it in the form without creating an associated custom form field or ACF field.

The Current Students, Alumni, and Faculty categories have an Elementor template to which all posts in their respective categories are mapped. These templates can be accessed in one of two ways. First, an administrator can locate the desired template from the “Templates” tab in
the dashboard menu. It is important to note that once the “Templates” tab is clicked, the administrator must click “All” or else no templates will appear. The administrator can also create a new Elementor template by clicking the “ADD NEW TEMPLATE” button at the top.

**Figure 25: Adding New Template**

Alternatively, an admin can find a template by selecting Templates -> Theme Builder -> Single Post. From here, they can also create a new template by clicking the “Add New” button at the top right.

Any change to a template will affect all posts within a certain category. The category to pick from is by adding a “condition” to the template. Before publishing a template, the user is prompted to add a condition and can change conditions through the check/edit/remove/add features by clicking the arrow next to the “Update” button and selecting “Display Conditions” as shown in Figure 26.
**Figure 26: Display Conditions Feature**
The Current Students template has the condition “Include, Post -> In Category, Categories: People > Current Students,” Figure 27 shows how the template affects only posts in the “Current Students.”

![Display Conditions Feature](image)

**Figure 27: Location of Template**
Default fields are filled in automatically using the widgets shown in Figure 28.

![Location of Template](image)

**Figure 28: Post Widgets**
Figure 29 demonstrates how to add text before and/or after the field value. To do this, click on the widget to open the edit menu, select the value with the wrench icon next to it in the “Content” tab, and enter the desired text in the associated inputs. The appearance of the field can be changed in the “Style” tab in its edit menu.
The values of ACF fields can be added to most text-based widgets represented by Figure 30. To insert the field, click on the stacked discs icon to open the “Dynamic Tags” menu and select “ACF Field” at the bottom.
Then, select the value with the wrench. From there, a user can add the field’s “Field Name” to the “Key” input in the "Settings" tab to map it to that field as shown in Figure 31. Additionally, a user can add text before/after the value of the field in the “Advanced” tab.

**Figure 30:** Setting ACF Fields

**Figure 31:** Specifying Value of ACF Fields
The appearance of these fields can also be changed in their container’s edit menu “Style” tab based on Figure 32.

The ACF field plugin adds text boxes at the bottom of the page that can be edited using the WordPress editor.

**Figure 32:** Result of ACF Field Plugin
To enter the WordPress editor to edit the values in the ACF fields for a certain page, an admin can search for the page in the “Posts” tab in the dashboard menu and click “Edit” as shown in Figure 33.

**Figure 33:** Edit ACF Fields for a Page
An admin can edit the CSS for an individual block by selecting Advanced -> Custom CSS in that element’s edit menu, as shown in Figure 34. The user can edit the CSS for the entire page by selecting Advanced -> Custom CSS in the page’s Settings menu. This can be accessed by clicking the gear icon at the bottom left.

![Figure 34: Customize CSS Attributes](image)

To update CSS for all categories of people, the user must edit all three categories separately.

**Developer Manual for T. M. Murali’s Personal Website:**

To access and edit the layout of Dr. Murali’s Personal Website, the user must be logged into WordPress using this link: [https://wordpress.cs.vt.edu/](https://wordpress.cs.vt.edu/)

Once the user is logged in, the user can view the dashboard and pages featured through the left sidebar. If all pages are selected, the user can view the pages made to create the website. The user can choose to add another page to the website with the add new page icon option. To change
the appearance of the website, the user can click on the appearance icon located on the left sidebar to view the themes available to the user. Each theme can be tested with the live preview button when hovering over the theme details. The current theme is set to Barletta. The theme can be customized by selecting customize, which is a subsection of the appearance icon.

Based on the goal and design of the client’s needs, the landing Home Page is information about Dr. Murali’s profile.

The website is structured in a similar format to Dr. Murali’s previous research website. The bar at the top of the page contains the sections: profile, research, publications, research group, software, collaborators, teaching, and news. This is shown in Figure 35.

![Figure 35: Murali’s Research Website Home Page](image)

The research section contains information about Dr. Murali’s main research areas and is formatted in a way such that each section is bolded and contains images that supplement the information stated, as shown in Figure 36.
The functioning of a living cell is governed by intricate networks of physical, functional, and regulatory interactions among different types of molecules. Recent experimental advances have yielded unprecedented insights into the structure of these interaction networks and into patterns of molecular activity (mRNA, proteins, and metabolites) in response to different conditions. The ultimate goal of my research is to build phenomenological and predictive models of these networks by developing approaches that investigate the relationships among the molecules in a cell. How these elements are organized into functional modules, how these modules interact with each other, and how different modules become activated or de-activated in various cell states. My research group develops algorithms and computational tools based on graph theory, data mining, and machine learning to obtain system-level insights into these basic biological questions by studying them in a comparative manner for example, across organisms, diseases, external perturbations, or cell states. This work is driven by collaborations with life science researchers spanning diverse fields including biochemistry, biophysics, infectious diseases, plant pathology, and tissue engineering. This page describes my group main research areas and also highlights some current and future research projects.

**Main Research Areas**

- Novel algorithms for network biology
- Discovery and analysis of functional modules
- Synthesis of bi-chains and hetero face-bridging
- Reaction pathways of macromolecular synthesis
- Real-time software system development
- Hybrid-synthetic protein engineering

**Figure 36: Murali’s Research Website Research Page**

Figure 37 shows the publications section, which contains information that lists the various publications that Dr. Murali has been a part of.

**Figure 37: Murali’s Research Website Publications Page**
Figure 38 shows the research group section which contains information about current students that are doing research with Dr. Murali. It also includes information about former students who have worked with Dr. Murali.

Figure 38: Murali’s Research Website Research Group Page

Figure 39 shows the software section, which contains information about software developed by Dr. Murali. That ranges across the categories of: Network and Pathway Analysis, Data-Driven Systems Biology, Predicting Gene Function, Gene Expression Analysis, and Data Mining.

Figure 39: Murali’s Research Website Software Page
The collaborators section contains information about active collaborators, and other collaborators, divided into two blocks, that if hovered over, the section highlights, as shown in Figure 40.

**Figure 40: Murali’s Research Website Collaborators Page**

The teaching section contains information about courses currently and previously taught by Dr. Murali, and the necessary links containing information about the courses, as shown in Figure 41.

**Figure 41: Murali’s Research Website Teaching Page**
Figure 42 is the news section containing links to Dr. Murali’s contribution to work in Computational Biology, as well as news about students that have worked with Dr. Murali, research papers/findings that Dr. Murali has been a part of, etc. Each section of the page is divided into years and contains clickable links to the relevant publications.

Figure 42: Murali’s Research Website News Page

Overall, Dr. Murali’s Research website contains sections that are formatted in a similar way to the previous website. The new research website has a more up-to-date theme that allows for more user engagement. The formatting of the website is clear and text placement is intentional to layout. For example, the sidebar at the top of the page allows for easy usability as the user can click on a different section without having to scroll to a different part of the page.
Reflections

To effectively meet our client's needs, we held weekly meetings that all team members attended consistently. Figure 43 shows the Trello board we set up to help manage our tasks, assign responsibilities and set clear deadlines for each team member.

![Figure 43: Trello Board](image)

Our main challenge came from our limited experience with WordPress. Our project required more than what the standard WordPress features could offer, leading us to add extra coding and plugins. Often, we found ourselves buying premium plugins to get the specific functionalities we needed. We spent a lot of time researching to find the right plugins that would meet our complex needs.

Despite these challenges, we made substantial progress. We successfully launched the CTE and Murali’s Research Websites on WordPress, adding new features like a search bar and automated forms. These improvements greatly enhanced the sites' functionality and overall user experience, showing our team's ability to adapt and stay committed to the project’s success.
**Future Plan**

A feature like randomization could be helpful, for example, randomly selecting a student from the current students page to be featured as a “spotlight.” This student would get their spotlight feature on a separate page that lists additional attributes about the student and the work that they are doing as part of the CTE program. Specifically, Figure 44 shows how this “spotlight” feature functions, by highlighting a random person to the left of the list.

![Figure 44: Student Spotlight](image)

Another recommended feature is filtering students based on attributes like program and recruiting class. As shown in Figure 45, the “Current Students” and “Alumni” sections allow the user to filter people by different categories.

![Figure 45: Filter Students](image)
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References


