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"Integrated Help"

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ABSTRACT— ***Teaching computer programming to novice programmers is a challenging job. One possible reason for this is that novice programmers struggle to understand internal manipulation of key programming concepts which causes misconception and difficulties. An observation study was conducted to investigate misconceptions and difficulty experienced by Novice Programmers. Study revealed three major findings - firstly, novice programmers found textual presentation of programming concept to be monotonous; they preferred alternative presentation in the form of – text, audio, video, animation, simulation etc. Secondly, Ergonomics of learning interface causes eye fatigue. Thirdly, to remove misconception when novice programmers search WWW due to numerous search results they suffer from 'lost-in-hyperspace' problem.***
Further, exhaustive survey on existing integrated programming IDE (C, C++, Java Editor, .net Editor, SQL Server, Oracle) revealed integrated help provided by majority of them, suffers from key findings of observational study. To address this, "Integrated Help" content presentation model is proposed. A series of studies established this model to be potentially effective. Learning material facilitated through "Integrated Help" was found to interesting and engaging. As a result it proved to be an aid to novice programmers to develop better understanding of key concepts.

Keywords— learning theories; content presentation; learning strategies; novice programmers

1. INTRODUCTION

Computer Programmers write codes that make computers user-friendly. They do this by writing code that can be of few lines to thousand of lines. Codes are written in programming languages. Programmers develop software by inter-communication of more than one language. Inter-communication of programming language requires endeavour and attention to programming concepts. The application cohesive coding knowledge is broad and far-reaching.

Producing effective and efficient computer programmers has never been an easy task for institution/university. This may be due to weak comprehension and visualization ability of novice programmers. A programmer has to constantly focus on programming IDE from few hours to many hours to write programming constructs. When a novice programmer is not able to implement logical thinking through programming than a search is made for programming construct. Mostly, search is done first on World Wide Web (WWW) than on "Integrated Help" of programming IDE. Search on WWW, results in numerous web pages landing novice learner in a havoc situation. As compared to this, search on "Integrated Help" results in limited learning material but its presentation is not learner engaging. If presentation of learning material provided through "Integrated Help" is made more learner engaging and interesting than it will prove to be more effective and efficient to novice programmers as compared to online help.

Thus, architecture and usability of "Integrated Help" of existing programming IDE's works as a centripetal force for developing programming ability of novice programmers. Actual mechanics of learning material provided through integrated help of programming IDE is the key for the development of viable mental models for learning programming. Mechanics of learning material bestowed through "Integrated Help" of programming IDE deals with Presentation of learning content, Media that supports presentation, Ergonomics (Typography, Colour, and Layout) and Hypermedia that transfer controls to other learning resources.

The work in this article is motivated by exhaustive survey conducted on available programming IDE. In the survey it was revealed that novice programmers often devote a lot of time searching for programming construct. There first preference of search is World Wide Web. But the search results on Word Wide Web are numerous resulting in the

problem of "lost-in-hyperspace". It was revealed in the survey that novice programmer's very rarely search "Integrated Help" of programming IDE. This is mainly due to lack of awareness, although "Integrated Help" do have all the syntax and semantics of programming constructs, and second reason is, monotonous presentation of programming construct. To readdress this deficiency, this article proposes and evaluates learning theories based content presentation model that integrates learning strategies of Cognitive Information Processing, Behaviourism, and Constructivism. This article report two key findings. Firstly, "Integrated Help" build on proposed model perk up the interest and engagement of learner with learning material. Secondly, Interface Design of "Integrated Help" developed on Ergonomic principles helps in reducing eye strains, neck and upper limb pain.

2. RELATED WORK

Learning content may be presented in variety ways. Content can be pieces of information, groups of objects, events or symbols that are identified by common characteristics, or sequence of steps or explanation or prediction. Component Display Theory (CDT) given by [1] works on content classification as per learner performances. Learning content may be presented through illustration, description; paired relationships etc. which may be categorized as **Presentation Types** based on CDT. Selection of presentation type depends on the type of information to be displayed. Presentation must be supported by appropriate media. Each media has different effect on retention, recall and cognitive processing. Different types of **Media** includes – text, audio, video, animation, images etc.

Often most common choice of presenting content is text. Text based screens are boring and show a lack of creativity. A lot of text on the screen leads to poor readability. According to [2] vertically arranged text is more efficient as compared to horizontal lines. But content presented only through text leads to poor concentration level and causes fatigue. Research study conducted by [3] revealed that content presented through pictures, graphics, videos, simulations, recorded audio are more learner engaging. Other media that may be utilized includes books/e-books, magazines, and e-mail. Learning content presented in different ways enhances grasping power of learners. Different learners have different sensitivity levels to different media. Thus, appropriate media selection is a critical issue in presenting content.

Central part of any content presentation is text. Despite the utility of audio, video, animation, images etc. which generates interesting content, improper use of typography may cause distraction. Next, parameter to study is **Ergonomics** which deals with typography, colour and screen layout. According to research conducted by [4] it was revealed that well-structured typography manages visual space and maintains optical balance, shapes textual order, thus gathers learner attention. Typography is the critical element which has direct impact on readability of the text. Other factors that affects readability includes line lengths, columns, window size and inter-linear spacing [5]. Length of the line displayed on the screen is one of the crucial parameter that affects readability. If physical length of the line is large than it causes additional eye movement leading to visual fatigue. Physical length of the line is dictated by typography as it decides font type, font size, character formatting and line spacing. Readability is also affected by number of lines per screen and line spacing. [6] proposed the utilization of golden ratio to set line spacing. Line spacing set as per golden ratio enhances readability.

Presentation with improper use of colour may cause distraction. Colour is the next inherent characteristics of Ergonomics. Colour work as a tool of non-verbal communication. They can set a mood, convey an emotion, invoke a psychological reaction or inspire people to take action. Colours must be utilized effectively in graphic elements and in text. Learning interfaces design is integration of graphic elements and text. Thus, colour should be utilized effectively since it has direct effect on concentration level and eye strains. Choice of foreground-background colour can be made though the utilization of colour wheel in terms of contrast and brightness. As per the study conducted by [7] a 3:1 luminance contrast value is ideal choice to optimize contrast between text and background. This study further provides factors that enhances readability and maximizes learning which includes – utilization of sans serif fonts, minimizing visual complexity, using white space judiciously and applying visual cues. According to the recommendation of World Wide Web Consortium W3C, text and images with insufficient contrast between foreground and background colour, works as hindrance for people with visual disabilities. In year 2003, Duebel conducted research study which recommended the use of dark colours for text to enhance readability. According to the Institute for Colour Research, colour can improve comprehension and thus learning outcome from 55 to 78 percent, further if right balance of colour is not utilized than it causes cognitive overload [8]. Thus, proper colour utilization in text, video, animation, images, audio and graphics termed as multimedia is a critical factor in content presentation.

Fenrich in 1997 provided definition of multimedia – "Multimedia is the exciting combination of computer hardware and software that allows you to integrate video, animation, audio, graphics, and text resources to develop effective presentation on affordable desktop computers" [9]. With the evolution of technology, multimedia components were linked together to form **Hypermedia**. In hypermedia, multimedia components are linked logically on the basis of common characteristics they bear among each other. In the year 1890 – 1974, Vannevar Bush introduced the concept of Hypermedia System by providing logical linkages to hypermedia. In the year 1960 Ted Nelson introduced the concept of

Hypertext which is one of the components of hypermedia system. Later on he developed hypertext editor to provide one step further to edit links into details. Further, research group at MIT developed hypermedia videodisc in the year 1976.

Effective utilization of hypertext and hypermedia may improve learning outcome of novice programmers. In an investigative study conducted by Hartley and Bendix in 2003 [10] it was found that knowledge level of novice learner is increased when learning is acquired through hypermedia tools. Hypertext and Hypermedia tools generate information network accessible through hyperlinks [11]. Hyperlinks provide alternative presentation of the learning artefact. As numbers of links are increased it causes problem of 'lost-in-hyperspace' leading to cognitive overload. The problem of 'lost-in-hyperspace' is mostly experienced by novice learner as they lack in prior knowledge. According to [12] large number of hyperlinks on the same learning artefact inhibits learning. Due to this digression, concept of backtracking was introduced which can backtrack to previously learned information pages [13].

Hyperlink is one of the navigational structures utilized to transfer control to other learning artefact. Other navigational structure that may be utilized includes Map, Concept Map, Friendly Guide, Icons, and Key Word Linking [14]. These navigational structures provide guided discovery. Structuring of these navigational structures is a critical issue. Tracing accessing pattern of learner, audit trails, connecting related words, and semantic network are some of the ways of designing network of logically related learning artefacts. According to [15] structuring of this network can also be done through block and hierarchical organization. Due to this structuring methods novice learners with low level of prior knowledge are able to avoid navigation problem in hypermedia systems [16]. Structured hypermedia systems increases interest and motivation to learn.

Survey was conducted on "Integrated Help" of existing programming IDE of C, C++, Java Editor, .net Framework Editor, SQL Server and Oracle. Table 1 below provides critical analysis of "Integrated Help" of C, C++, Java Editor, .net Framework Editor, SQL Server and Oracle on four parameters – **Presentation**, **Media**, **Ergonomics**, and **Hypermedia**.

Table 1 Comparative Analysis of "Integrated Help" on Parameters to study

	C	**C++**	**.net Editor**	**Java Editor**	**SQL**	**Oracle**
Presentation	✖	✖	✓	✓	✓	✓
Media	✖	✖	✖	✖	✖	✖
Ergonomics	✖	✖	✖	✖	✖	✖
Hypermedia	✖	✖	✓	✓	✓	✓

Table 1 reveals that **Media** and **Ergonomics** are two parameters that are not considered in designing of "Integrated Help" of C, C++, .net Editor, Java Editor, SQL and Oracle. "Integrated Help" of C and C++ editor is text based and it does not consider any of the parameter listed in Table 1. Thus, it became need of time to redesign "Integrated Help" that can present learning material generated on prior experimental research findings in the domain of learning theories and educational technology.

3. INVESTIGATING THE PRACTICALITY OF EXISTING PROGRAMMING IDE'S

To investigate the practicality of existing programming IDE's observation study was carried out for six months. 90 Bachelor of Engineering/Master of Computer Application novice programmers were recruited towards the end of their course.

They were provided training on C, C++, Java, .net framework, SQL Server and Oracle. Observation was carried out without informing them about research study to be conducted. During study it was observed that learners mostly relied on instructor for help instead of exploring "Integrated help" of editors. Later on, learners were given instructions to explore "Integrated Help" of editors.

It was observed that these novice programmers were hesitating in exploring "Integrated Help" of editors. On indirect questioning about this behaviour it was revealed that they did not considered "Integrated help" to be useful as they were not able to explore the desired programming construct in "Integrated help". Though, 20 participants were able to explore the "Integrated help" but for short duration of time. 18 Participants took help from instructor to explore "Integrated help".

Remaining 52 participants, experienced major difficulty in exploring "Integrated help". From the study it was revealed that novice programmers had difficulty in understanding programming construct in text format. Understanding of programming construct depends on the visualization of execution process. Existing "Integrated Help" of programming IDE (C, C++, Java Editor, .net Framework, SQL Server, Oracle) neither provides visualization nor its alternative mode consisting of audio, video, text, animation, simulation or combination of these.

Next difficulty that novice programmers experienced was related to Ergonomics (Typography, Colour and Interface Layout) of "Integrated Help". It was observed that when novice programmers gazed on "Integrated Help" interface for considerable amount of time they use to rub their eye which was clear indication of eye strains. Eye strain was caused due to white background (glare from white background) of "Integrated Help" (in case of Java, .net, SQL server and Oracle editors). Few of the novice programmers reported to have difficulty in reading text from the screen which may be due interlinear spacing, improper font size, font type etc. because of which they had to change their viewing angle by tilting there neck. Due to this at the end of training few of them reported to have neck and upper limb pain.

Study revealed that 'lost-in-hyperspace' is the most common problem experienced by novice programmers. "Integrated Help" had hyperlink that connects logically related programming constructs. Due to insufficient logical thinking (programming ability) most of the programmers got navigated to programming constructs that was not related to their search criteria (search conducted on "Integrated Help"). This may be due to inappropriate utilization annotated links. Due to this they got trapped in 'lost-in-hyperspace' problem. Figure 1 gives graphical representation of novice programmer's attitude and behaviour towards existing "Integrated Help" of C, C++, .net Framework, Java Editor, SQL Server, and Oracle.

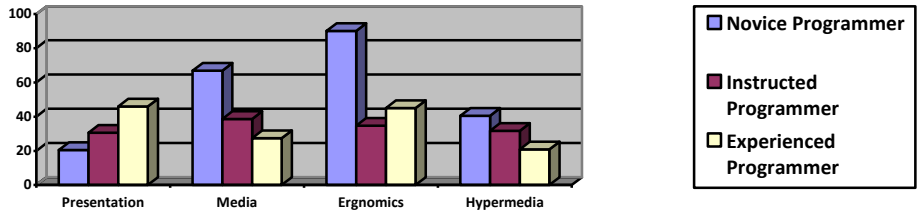

Figure 1. The percentage of each group separated based on difficulty experienced

From figure 1, it is evident that novice programmers experienced highest difficulty with ergonomics, than with media and Hypermedia. Whereas, experienced programmers found Presentation of learning material likely to be improved as compared to other parameters Media, Ergonomics and Hypermedia.

To summarize, this initial study revealed that "Integrated Help" of most of the programming IDE had syntax and semantic of all programming constructs but due to its inapt presentation novice programmers avoid accessing it. They search on WWW for their programming construct which raises their difficulty level. As a result, this research study proposes, Content Presentation Model to develop "Integrated Help". Content Presentation Model is based on experimental research findings in the domain of Learning Theories and Educational Technology, providing guidelines for appropriate presentation of learning material supported by, Media selection model, Ergonomic principles and Hypermedia rules. Supporting the development of this model is the subject of the remainder of this section.

4. CONTENT PRESENTATION MODEL FOR "INTEGRATED HELP"

Learning may be defined as acquisition of behavioural changes due to individual experiences, except those due to maturation and growth. It is also regarded as a process of stimulus, response and reinforcement [17]. Learning performance depends on learning attributes. Learning attributes are essential to achieve effective and intended learning outcomes. To achieve intended learning outcome learner must possess learning ability, articulate knowledge understanding, requisite aptitude and positive attitude.

On conducting analysis of Behaviourism, Cognitivism, and Constructivism 11 learning attributes were identified [17], [18]. Thus key learning attribute for effective learning includes:

- **Finding and Exploring**:

  It refers to the process of developing curiosity about surrounding periphery of learner.

- **Involvement and Concentration:**

  It refers to innovative thinking and selecting alternative ways to do things. It is achieved through problem solving, high order thinking, and deep understanding.

- **Apprentice:**

  It refers to acquiring skills by getting trained under the supervision of experienced and skilful person.

- **Building Linkages:**

  It refers to utilization of prior knowledge and linking it to new knowledge. These linkages helps learner in deducing conclusion by grouping, sequencing and cause-n-effect relationship.

- **Collaboration:**

  It refers to engaging learner with peers for discussion and meaningful construction of knowledge.

- **Scaffolding:**

  It refers to support and guidance provided by expert to achieve learning objective.

- **Multi-modal Presentation:**

  It refers to delivery of instruction through multiple modes – audio, video, text, and sound/images.

- **Motivation and Feedback:**

  It refers to remedial comments provided to rectify errors and designing of learning activities that motivates learner.

Thus, these learning attributes along with integration of technology in education helps to attain effective and efficient "Integrated Help". "Integrated Help" based on pedagogical perspective (learning attributes) and core principles of Behaviourism, Cognitivism, and Constructivism facilitates in generating learner engaging content.

In programming education domain their exists attractive package of services and tools but the majority of them suffers from serious deficiencies which includes –

- Learning theories based Content Delivery
- Interface Design
- Preservation of learner focus

Proposed Content Presentation Model works on these deficiencies. Figure 2 gives Content Presentation Model based on learning theories followed by its tabular presentation stating guidelines that may be followed to design interesting and engaging learning facilitated through "Integrated Help".

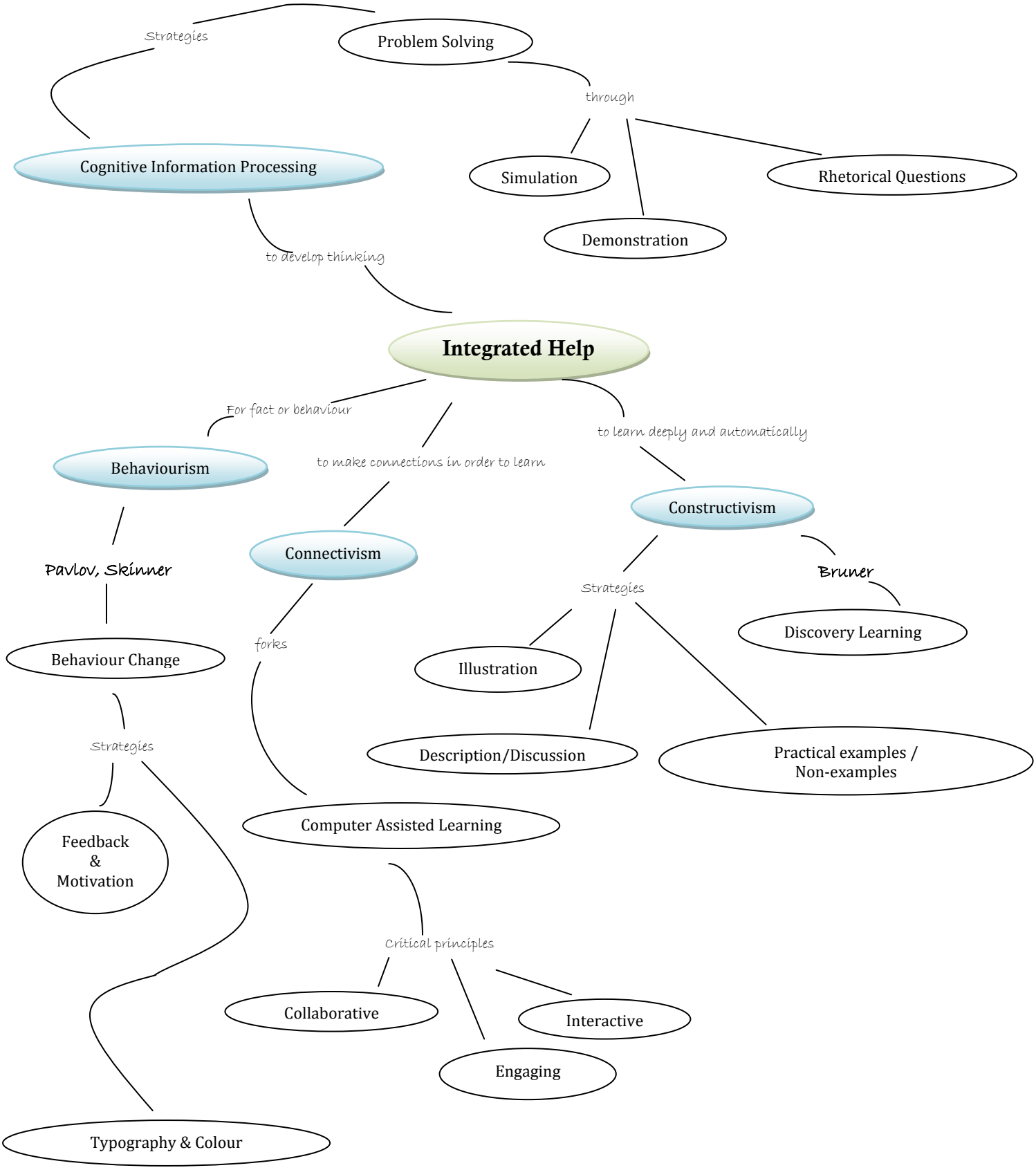

Figure 2. Learning Theories involved in "Integrated Help"

In programming education domain a novice programmer has to learn, execution procedures of programme instructions, different data types, and their range of accepting values, syntaxes that has to be followed in a particular programming domain. Thus, to understand these programming facts a novice programmer has to depend on their instructor or refers "Integrated Help" of programming IDE. As a result, proposed study taking Merrill's Component Display Theory (C D T) as base research provide guidelines to design "Integrated Help" on four pillars – Presentation, Media, Ergonomics and Hypermedia:

Overview	
Presentation	➢ State the goals of the topic, clearly and precisely. ➢ State problems that topic will be dealing with. ➢ State Criteria of Success. ➢ Conclude with an indication or a question, to follow up.
Media	➢ Start always with brief textual material. ➢ May use audio or video.
Ergonomics	***Graphic Aesthetic*:** ➢ Maintain Cohesion and Proportion [19]. ➢ Use aesthetically pleasing shapes such as Golden Rectangle to display Overview [19]. ***Typography*:** ➢ Display Overview as Single Page Column format [5]. ➢ Ensure adequate character-spacing to enhance readability [20]. ➢ Readability is enhanced for 40 lines per screen (Kruk & Muter, 1984). ➢ Set Font type to 'Comic Sans MS' (Bernard, Mills & Peterson, 2001). ➢ Set Font Size to 12 point (1.5em for web) [23]. ➢ Set Characters Per Line (CPL) to 75 [24]. ➢ Ensure line-spacing preferably two points larger than the typeface [20]. ➢ Typeset/typeface may be medium, bold or italic in large or small type, boxed in etc. [25]. ➢ Use Left-hand alignment of paragraphs to increases readability, as compared to justification [20]. ***Color Psychology*:** ➢ Use well-contrasting cool colors-Black/Green on light-beige/Gray- as it is soothing to eyes [26]. ➢ Add color to your heads and subheads with a stronger weight; a different color to a quote, passage, or short story to catch learner's attention [27]. ➢ Limit to three colors as maximum and hot-colors as rare-necessity, and maintain consistently.
Hypermedia	➢ Stretch text arousing leaner to click and read full text. ➢ Anchor Adaptation to present key words as hot words. ➢ Hyperlink to link learning media content.
Don'ts	➢ Avoid using more than one text alignment, all-caps, hyphens as bullets and different fonts. ➢ Avoid two or more typefaces from the same category on the same page - Serif for low resolution and small screen [20].

Fact	
Presentation	➢ State illustration or description or paired relationship with examples. ➢ State rhetorical questions consisting of examples and feedback in the form of correct answer. ➢ State patterns of letters, ideas or associations. ➢ Include at most 5-7 facts to be displayed at a time; it may be in random order.
Media	➢ Use Charts for illustration. ➢ Use photograps for Paired relationships. ➢ For static objects and events use Slides [28]. ➢ For diagrammatic representation of static objects use Images [28].
Ergonomics	***Graphic Aesthetic:*** ➢ Maintain Balance, Sequence, Cohesion, Proportion and Unity [19] of screen layout. ➢ Contrast small graphic with large graphic [27]. ➢ All the edges on the page must be aligned with other edges of graphic element [27]. ➢ For proximal items- Size or Weight or Placement of text or graphics should be varied [2= ➢]. ➢ Group logically related information [27]. ***Typography:*** ➢ Text should be displayed as Single Page Column format [5]. ➢ Set number of lines on screen to 40 it enhances readability [21] or Amount of text to be displayed on screen must be low in density [5]. ➢ Utilize Double line spacing (2em for Web) to enhance readability [5]. ➢ Set right margins unjustified, and put blank lines between paragraphs [5]. ➢ Text should be displayed as Single Page Column format [5]. ➢ Set Font type to 'Comic Sans MS' [22]. ➢ Set Font Size to 12 point (1.5em for web) [23]. ➢ Set Characters Per Line(CPL) to 75 [24]. ***Color Psychology*:** ➢ Use well-contrasting cool colors-Black/Green on light-beige/Gray- as it is soothing to eyes [26].
Hypermedia	➢ Concept Map having icons that users can click [14]. ➢ Guided Tours [15]. ➢ Stretch Text arousing leaner to click and read full text. ➢ Anchor Adaptation to present key words as hot words. ➢ Hyperlink to link learning content.
Don'ts	➢ Avoid placing graphic or element in the middle or corner. ➢ Avoid using flashing or blinking graphics as it distracts new learner as well as person suffering from glaucoma or cataracts [20].

Concept	
Presentation	➢ State illustration or description or paired relationships or paraphrasing with examples. ➢ By unveiling relationship between objects, events or symbols. ➢ State complex concept from easy to hard containing rhetorical questions with examples. ➢ Giving explanation through patterns of letters, ideas or associations for remembering facts. ➢ State cause-n-effect relationship and ask learner to find explanation for the events observed.
Media	➢ Utilize images or charts to unveil relationship between objects or to categorize objects (Kozma, 1991). ➢ To reflect cause-n-effect relationship utilize animation [30] ➢ To reflect changes or relationship in objects - Use time-lapse photography, animation or movie [31]. ➢ To explain multiple perspective with comparative examples - Use combined audio and graphic together [31].
Ergonomics	***Graphic Aesthetic*:** ➢ Maintain Balance, Unity, Cohesion, Proportion and Unity [19] of screen layout. ➢ Club logically related information [27]. ➢ Align edges of graphic element with other edges on the pages [27]. ***Typography*:** ➢ Text should be displayed as Single Page Column format [5]. ➢ Reading is faster for 40 lines on screen [21]. ➢ Utilize Golden ratio to decide font size and interlinear spacing. ➢ Utilize Double line spacing (2em for Web) to enhance readability [5]. ➢ Set right margins unjustified, and put blank lines between paragraphs [5]. ➢ Text should be displayed as Single Page Column format [5]. ➢ Set Font type to 'Comic Sans MS' [22]. ➢ Set Font Size to 12 point (1.5em for web) [23]. ➢ Set Characters Per Line (CPL) to 75 [24]. ***Color Psychology***: ➢ Utilize red or orange and highlighted or boldface text in graphics or animation to draw attention (Norma S. Pribadi, Maria G. Wadlow, 1990;Williams, 2004).
Hypermedia	➢ Utilize Inserting/Removing/Alternating Fragment to display/hide artifact. ➢ Design Environment for Guided discovery[15]. ➢ Utilize Anchor Adaptation to represent key words into hot words. ➢ Utilize Hyperlink to link learning content for in depth analysis. ➢ Utilize SVG to represent graphics into two dimensional formats.
Don't	➢ Instruction referring objects by colors [20]. ➢ Color combination such as blue and yellow or red and green [20]. ➢ Too many big and bold and flashy items on the page [27]. ']

Procedure	
Presentation	➢ State illustration or description or paraphrase consisting rhetorical questions - Embedded examples with correct answer feedback ("Expectancy Value Theory" 2016). ➢ Utilize flow chart for explanation. ➢ Utilize formal statements or diagram to describe activity to be conducted to attain procedural goals. ➢ By demonstration of procedures/methods. ➢ Rhetorical questions to engage learner.
Media	➢ For representing working of complex equipment or complex procedures - Utilize videos of comparable cases, visualization, three-dimensional models, simulators [28], [33], [34]. ➢ To present explanation through multiple perspectives with comparative examples utilize audio with graphics. [28], [33]–[35]. ➢ To explain working of procedures utilize videos [30]. ➢ Utilize automated prompts on learner actions to engage learner[36].
Ergonomics	***Graphic Aesthetic*:** ➢ Maintain Cohesion and Proportion [19]. ➢ Maintaining Aspect Ratio of graphic elements. ➢ Use aesthetically pleasing shapes such as Golden Rectangle to display sequential steps [19]. ***Typography***: ➢ Text should be displayed as Single Page Column format [5]. ➢ Reading is faster for 40 lines on screen [21]. ➢ Utilize Golden ratio to decide font size and interlinear spacing. ➢ Utilize Double line spacing (2em for Web) to enhance readability [5]. ➢ Set right margins unjustified, and put blank lines between paragraphs [5]. ➢ Text should be displayed as Single Page Column format [5]. ➢ Set Font type to 'Comic Sans MS' [22]. ➢ Set Font Size to 12 point (1.5em for web) [23]. ➢ Set Characters Per Line (CPL) to 75 [24]. ***Color Psychology***: ➢ Use well-contrasting cool colors-Black/Green on light-beige/Gray- as it is soothing to eyes [26]. ➢ Use color wheel for appropriate color selection [20].
Hypermedia	➢ Utilize altering/inserting fragment to represent alternate information. ➢ Utilize link Annotation for appropriate link selection. ➢ Utilize Anchor Adaptation to represent key words into hot words. ➢ Use Scroll Animation for heavy text displays. ➢ Utilize Backtracking to overcome the problem of 'lost-in-hyperspace' [37]. ➢ Utilize Bookmarks to Embed links to revisit pages [37]. ➢ Utilize SVG to display graphics.
Don't	➢ Avoid using flashing or blinking graphics. ➢ Avoid color combinations such as blue and yellow or red and green in images or text.

Principle	
Presentation	➢ Present formal law consisting of illustration or description having rhetorical questions with examples. ➢ Present non-examples with explanation. ➢ State real-world metaphors that match working of principle. ➢ Stating specific conditions under which particular principle works. ➢ Utilize predict-practice exercises stating what will happen next under specific conditions. ➢ Stating conditions and explaining its effects on observed events through formal statement.
Media	➢ To develop principles and explanatory theories - Utilize motion pictures consisting films, video, simulations, time-lapse photography and animations [28], [33], [38]. ➢ Use audio with graphics [35]. ➢ Images of real-world metaphor.
Ergonomics	***Graphic Aesthetic***: ➢ Maintain Balance, Cohesion and Proportion [19]. ➢ Maintain aspect ratio graphics. ➢ For proximal items - Size or Weight or Placement of text or graphics should be varied [27]. ➢ Align edges of graphic element with other edges on the pages [27]. ➢ Use aesthetically pleasing shapes such as Golden Rectangle to display case-studies [19]. ***Typography***: ➢ Text should be displayed as Single Page Column format [5]. ➢ Reading is faster for 40 lines on screen [21]. ➢ Utilize Golden ratio to decide font size and interlinear spacing. ➢ Utilize Double line spacing (2em for Web) to enhance readability [5]. ➢ Set right margins unjustified, and put blank lines between paragraphs [5]. ➢ Text should be displayed as Single Page Column format [5]. ➢ Set Font type to 'Comic Sans MS' [22]. ➢ Set Font Size to 12 point (1.5em for web) [23]. ➢ Set Characters Per Line (CPL) to 75 [24]. ***Colour Psychology***: ➢ Utilize color to draw attention and to enhance retention [26]. ➢ Utilize color wheel to select color [20]. ➢ Utilize highlighted and boldface text in graphics or animation[26]. ➢ Use well-contrasting cool colors - Black/Green on light - beige/Gray- as it is soothing to eyes [26].
Hypermedia	➢ Utilize Fish-Eye diagrams to focus on key relationship and give glimpses of associated principles [37]. ➢ Utilize Backtracking and History notes to backtrack to learning path [37]. ➢ Utilize Inserting/Hiding/Alternating/Removing Fragment to display learning material on user click. ➢ Utilize Anchor Adaptation to display keywords into hot words. ➢ Use SVG for writing interactive multimedia presentation.
Don's	➢ Avoid flashing and blinking graphics. ➢ Avoid color combination such as blue and yellow or red and green in images and text [20].

Assessment	
Presentation	➢ Diagnosing learner through aptitude test or discussion or asking questions. ➢ Utilize summative assessment (test, assignment or presentation). ➢ Use formative assessment (quick quizzes, engaging exercises). ➢ Investigating cause and effect relationship through Divergent questions (Compare and Contrast, finding relationships, and finding similarities and differences).
Media	➢ Presentation of embedded questions in video-based materials [39]. ➢ Assessment questions through text in written form or in auditory form but not in both [40]. ➢ Utilize diagrams to find similarities and differences(Kozma, 1991). ➢ Utilize state-predict exercises. ➢ Asking learner to apply principles in a modified situation[41].
Ergonomics	***Graphic Aesthetic:*** ➢ Maintain Balance, Cohesion and Proportion of screen layout [19]. ➢ For proximal items - Size or Weight or Placement of text or graphics should be varied [27]. ***Typography:*** ➢ Text should be displayed as Single Page Column format [5]. ➢ Utilize Golden ratio to decide font size and interlinear spacing. ➢ Reading is faster for 40 lines on screen [21] or Amount of text to be displayed on screen must be low in density [5]. ➢ Utilize Double line spacing (2em for Web) to enhance readability [5]. ➢ Set right margins unjustified, and put blank lines between paragraphs [5]. ➢ Text should be displayed as Single Page Column format [5]. ➢ Set Font type to 'Comic Sans MS' [22]. ➢ Set Font Size to 12 point (1.5em for web) [23]. ➢ Set characters Per Line (CPL) to 75 [24]. ***Colour Psychology:*** ➢ Limit to three colors as maximum and hot-colors as rare-necessity, and maintain consistently. ➢ Use color wheel for appropriate color selection [20].
Hypermedia	➢ Utilize Overview Diagrams having hot spots [37]. ➢ Utilize Bookmark/Backtracking to go back to previous exercises [37]. ➢ Utilize Link Annotation/Anchor Adaptation/Hyperlink for appropriate link selection. ➢ Use Altering Fragment to display alternate information for in-depth analysis.
Don'ts	➢ Avoid inconsequential words and pictures [40]. ➢ Avoid instruction referring objects by color [20]. ➢ Avoid placing unrelated items or information in close proximity.

Feedback & Motivation	
Presentation	➢ Give feedback through correct answer, wrong answer, help and hint. ➢ Give feedback in the form of hints while carrying out procedure. ➢ Motivating learners by presenting time-bound activities [42]. ➢ Motivating learners by relating theories/principles to real world scenarios. ➢ Motivating learner by including rewarding activities (such as Beginner Code championships).
Media	➢ Utilize metaphor to transfer fast feedback. ➢ Using beep sound to indicate correct/wrong answer. ➢ Utilize meaningful images or icons representing context and content to give feedback. ➢ Using animations at interval to demonstrate main ideas or complex topics. ➢ Introducing novelty, surprise, uncertainty, complexity or ambiguity through text, audio or video to motivate learner [42], [43]
Ergonomics	***Graphic Aesthetic:*** ➢ Maintain Balance, Cohesion, and Proportions of graphic elements [19]. ➢ Use directions to enhance aesthetic or communication of the piece [27]. ➢ Use aesthetically pleasing shapes such as Golden Rectangle to display Overview [19]. ➢ For proximal items - Size or Weight or Placement of text or graphics should be varied [27] ***Typography****:* ➢ Utilize Left-hand aligned text in feedback since it enhances readability [20]. ➢ Utilize Double line spacing (2em for Web) to enhance readability [5]. ➢ Utilize short sentences. ➢ To gather attention on particular word present it as Bold/Italics words. ***Colour Ergonomics***: ➢ Utilize red or orange color to draw attention on feedback [27].
Hypermedia	➢ Utilize dimming fragment for fade out effect. ➢ Hiding/Disabling/Removal of animation/graphic/hints utilized in feedback. ➢ Utilize SVG to motivate learner.
Don'ts	➢ Avoid all caps in feedback [27]. ➢ Avoid color text as it is harder to read [20].

Proposed "Integrated Help" based on Content Presentation Model works at four stages:

- *The role of prior knowledge on learning programming:*

  Prior knowledge has a significant role in learning programming. Prior knowledge level of novice programmers decides the difficulty level of learning material to be presented through "Integrated Help". Difficulty level directly affects learner engagement and critical thinking. Hence, assessing prior knowledge level related to programming skills is a critical factor as learner builds on what they already know.

  Strategies opted to assess prior knowledge level includes:

  - Asking Rhetorical Questions:

    Before the beginning of the course module novice programmers are asked rhetorical questions:

Examples of Rhetorical Questions include:

- Is this variable declaration correct?
- If this is the assignment, what will be the value of variables?
- Can you imagine memory assignment to variables?

Based on their answers instructor facilitate learning activity from "Integrated Help".

- Making novice programmer to work on basic programming construct:

  Making novice programmer to write basic programme that will be utilized to build higher order programmes. On basis of their mistakes instructor will decide what will be the difficulty level of instructional material to be provided through "Integrated Help".

- Making novice programmer aware of their programming skills and level of hard work they had to do:

  In beginning exercises it is the responsibility of instructor to make novice programmers aware of their programming skills and level of hard work they had to do to attain logical thinking. This is done by "compare - n - contrast", "paired-relationship", "state-predict" exercises etc. If logical thinking level is found to be too low than remedial learning activities will be facilitated through "Integrated Help".

- *The role of cognitive load in learning programming:*

  Novice programmers have to understand programming constructs. Programming constructs are interactive and varies in difficulty level. To understand their functionality novice programmers has to comprehend sequential flow of programme execution, module interactions, library cohesion etc., which increases cognitive load. "Integrated Help" of proposed model presents programming construct in alternative forms – text, audio, video, animation, GIF images etc. through which visualization was made easier, hence reduces cognitive load.

- *Scaffolding and supporting students as they develop programming skill:*

  Concept and theories of programming problems are presented to novice programmers in alternative forms and in small chunks. Instructors through "Integrated Help" facilitate task-example-solving strategies and goal-free questions to novice programmers. Further support is provided through description of - principles on which programming problem is based, task statement, input list, output formats, relevant formulas, and illustration of programming construct diagrams. This scaffolding is facilitated by Content Presentation Model based "Integrated Help" through – "Virtual Programming Books", "Programming Practice Questions", "Programming Competitive Questions", "Graphical Representation", "Algorithms", "Solution Description" etc.

- *The role motivation and feedback dimension in learning programming:*

  As soon as difficulty levels of programmes are increased novice programmers are de-motivated due to which they either avoid higher order programming or they focus on low order programming landing them in the world of inefficient programmers. Thus, to evolve novice programmers as an effective and efficient programmer they need to be motivated. Motivation can be done through animation, correct/wrong answer feedback, beep sound etc. Proposed model facilitates with guidelines to provide motivation and feedback through "Integrated Help". Thus, motivation is an essential factor in manufacturing skilled and strong logical thinking programmers.

5. EVALUATION OF PROPOSED LEARNING MODEL BASED "INTEGRATED HELP"

This section investigates the effectiveness of the "Integrated Help" based on proposed Content Presentation Model. In addition, special emphasis is laid on generating interesting, motivating and engaging learning materials.

- Research Method

  Two groups were formed first group consisted of experts working in the domain of education technology and another group consisted of peers having Teaching and Learning experience. In preliminary investigation experts conducted group discussion with novice programmers to identify mental models possessed

by them. Later on peers having Teaching and Learning experience investigated cognitive conflict that novice programmers held.

- Results

In group discussions experts identified inappropriate fundamental programming constructs held by novice programmers. On further discussion it was revealed that this was due to lack of presentation of programming constructs. 50 novice programmers reported to have monotony in presentation of programming constructs (mainly textual presentation). Due to this they were unable to visualize execution flow of programming constructs raising difficulty level of comprehension. Hence, experts group proposed to have multi-modal representation of programming constructs on the guidelines of Content Presentation Model.

Peer group having Teaching and Learning experience assisted in developing guidelines to be incorporated in "Integrated Help". Peer group provided techniques of motivating novice programmers. It was found that 30 out of 52 novice programmers were motivated though techniques advised by peer group. Based on this result, these motivating techniques were incorporated in Content Presentation Model based "Integrated Help". It was later revealed that it also worked as cognitive load reducer.

Proposed model is still in beta phase of development and will further undergo rigorous statistical testing.

6. CONCLUSION

This research study proposes and evaluates learning theory based teaching model that reduces cognitive load and provide scaffolding and support to learner through "Integrated Help". It improves programming concept held by novice programmers. The key findings in this research are as follows:

- "Integrated Help" works as a backbone in improving programming as it is available offline. Novice programmer may take help as and when required.
- "Integrated Help" categorizes learning material on Merrill's Component Display Theory (C D T) which is rigorously tested and applied. Learning material is pedagogically efficient and based on learning theories.
- Ergonomics of "Integrated Help" is appreciated by Experts of educational technology domain and peers of Teaching and Learning co-domain. Proposed ergonomic principles reduces eye strains and neck pain which novice programmers suffers from due to constant focus on screen.
- "Integrated Help" bestow scaffolding and support to novice programming through Hypermedia Navigational Structures. Proposed Navigational Structures solves the problem of "lost-in-hyperspace".
- "Integrated Help" provide guidelines for motivation and feedback to novice programmers. Hence, escalating their mood to study and thereafter rectifying their errors through feedback.
- Learning material is facilitated from "Integrated Help" on the basis of prior knowledge. Prior knowledge is evaluated through techniques proposed in section 4 of this article.
- "Integrated Help" offer alternative presentation of programming constructs in the form of text, animation, audio, video, simulation, images as a result helps in reducing cognitive load.

There is evidently sizeable future work to be carried out in this area, including more careful investigation on sample size of 2500 novice programmers and thereafter, utilizing results to move proposed model in the Artificial Intelligence sphere of influence. Artificial Intelligence will provide more dynamic "Integrated Help" based user interactions.

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