



**Warning:** Redistribution or publication of this document or its text, by any means, is strictly prohibited. Additionally, publishing the solution publicly, at any point of time, will result in an immediate filing of an academic misconduct.

## 1 Purpose

The purpose of this assignment is to practice files, inner classes, ArrayLists and Linked Lists, and other related topics.

## 2 Introduction

Every school day, the students at an elementary school are tasked with picking a new vocabulary word from a topic specified by their teacher, Mrs. Jones. While the students are having fun with their daily ritual, Mrs. Jones is busy collecting, organizing, and managing a database of hundreds of words, listing them under associated topics.

Turning to you for help, Mrs. Jones would like you write a menu-driven interactive program that allows her students to enter their new vocabulary words for a topic, or even create their own new topics. Specifically, she envisions a program that can interact with her students through a user interface similar to the menu shown below:

### Sample input file

```
# Sports
Hockey
racing
puck
running
ball
tennis racket
running shoes

# Food
Candy
hot-dog
cheese
burger
```

## 3 Input

The input file contains one word per line, with each **topic name** preceded by the symbol '#'. Blank lines and the spaces before and after the symbol '#' play no role and can be ignored.

## 4 Terminology

In this assignment, we use the term **Vocab** to refer to an object wrapping a topic name and the vocabulary words associated with that topic.

### Vocabulary Control Center

- 1 browse a topic
- 2 insert a new topic before another one
- 3 insert a new topic after another one
- 4 remove a topic
- 5 modify a topic
- 6 search topics for a word
- 7 load from a file
- 8 show all words starting with a given letter
- 9 save to file
- 0 exit

Enter Your Choice:

## 5 Requirements

1. Implement from scratch a doubly linked list to store the `Vocab` objects.
2. Implement from scratch a singly-linked list to store the words within the `Vocab` objects.
3. Option 8 is required to extract, from all of the `Vocab` objects, all the words that begin with the same letter specified by the user.  
This option must store the extracted words into an `ArrayList<String>` and then sort and print the resulting `ArrayList<String>`.
4. Option 9 must save all the topic names and associated vocabulary words to a text file, using the same format as used by the sample input file shown on page 1.
5. You must implement the node classes of your linked lists as private inner classes.
6. Using generics in this assignment is optional.
7. Feel free to design your own user-friendly interface, introducing more effective menus and services.
8. Except for the `ArrayList` class that you are required to use in part 3 above, your program may not use any member of the Java family of Collection of structures.
9. The actual input file is bundled and posted with this assignment file.

## 6 Visualization of the Linked Lists in Assignment 3

- Using another toy input file with more entries than the one shown on page 1, the diagram on the next page depicts the organization of the linked list structures in Assignment 3.
- To make clear that the node structures used by your linked lists classes `DoublyLinkedList` and `SinglyLinkedList` are different, the name
  - `DNode` is used to refer to the nodes in `DoublyLinkedList`, and
  - `SNode` is used to refer to the nodes in `SinglyLinkedList`

However, Since the node structures are each required to be defined as `private` inner classes of their respective linked lists, they can each be simply named `Node`, or any name at all.

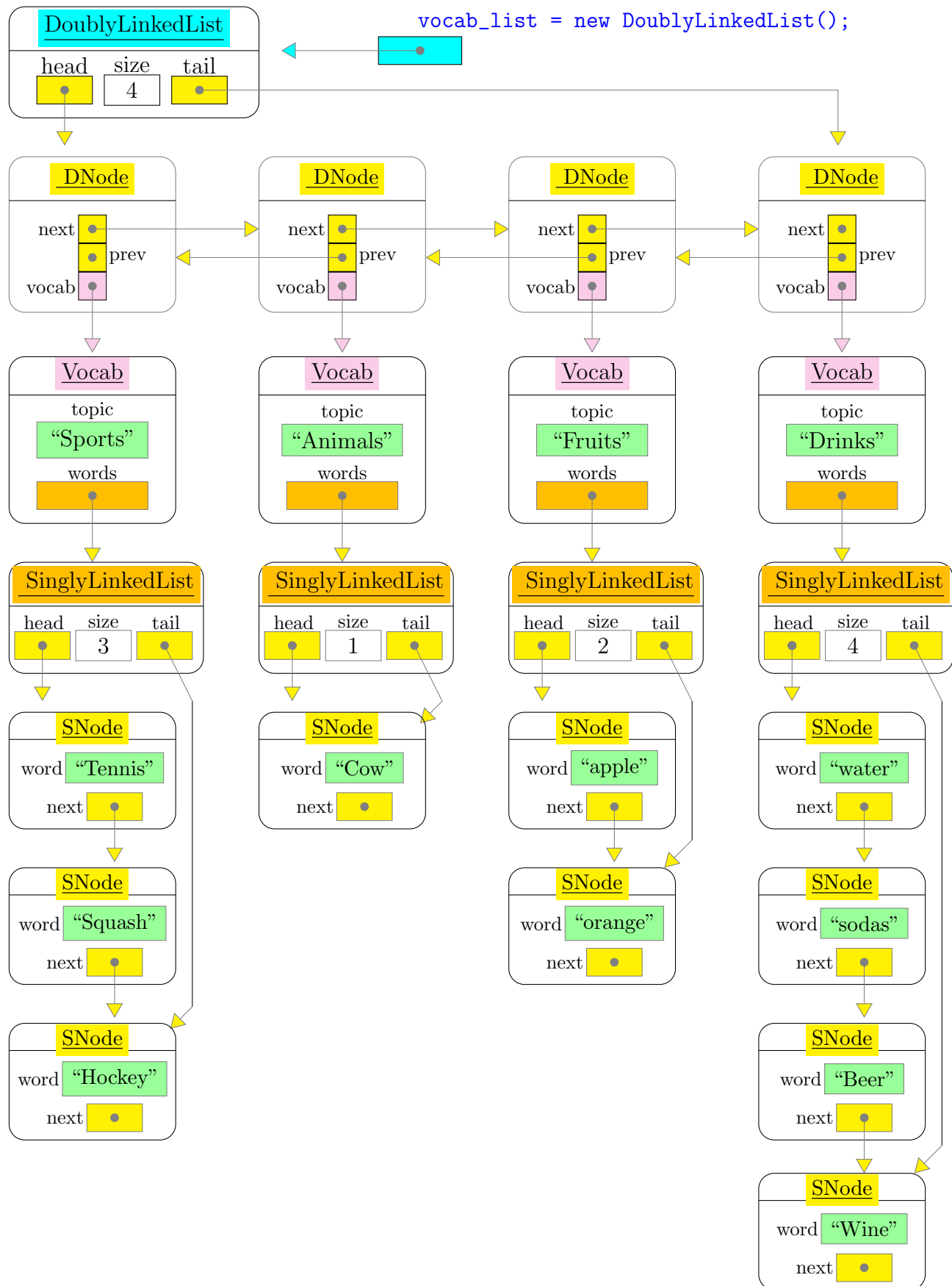
- Depending on your design, your linked list structures may be different.

For example, your linked list may or may not

- use `size` and/or `tail` attributes
- use dummy header and/or trailer nodes
- be circular

each of which is optional and acceptable; all you need to do is to implement the lists from scratch.

- The diagram presented on the next page uses typical linked list structures.



## 7 Sample program Run

To minimize the amount of output in this presentation, the following sample run of the program uses the sample toy input file shown on page 1 to load our `vocab_list`.

Please note that regardless of the input files you use during the development of your program, your final work will be tested using the input file bundled and posted originally with this assignment.

```
1  -----
2  Vocabulary Control Center
3  -----
4  1  browse a topic
5  2  insert a new topic before another one
6  3  insert a new topic after another one
7  4  remove a topic
8  5  modify a topic
9  6  search topics for a word
10 7  load from a file
11 8  show all words starting with a given letter
12 9  save to file
13 0  exit
14 -----
15 Enter Your Choice: 7
16 Enter the name of the input file:
17 input_topics_words.txt
18 Done loading
19 -----
20 Vocabulary Control Center
21 -----

22 1  browse a topic
23 2  insert a new topic before another one
24 3  insert a new topic after another one
25 4  remove a topic
26 5  modify a topic
27 6  search topics for a word
28 7  load from a file
29 8  show all words starting with a given letter
30 9  save to file
31 0  exit
32 -----
33 Enter Your Choice: 1
34 -----
35 Pick a topic
36 -----
37 1  Sports
38 2  Food
39 0  Exit
40 -----
41 Enter Your Choice:
```

We chose option 7, at line 15, although we could continue with an empty words database, i.e., `vocab_list`.

As you can see, our toy input file has been read, creating the two topic names `Sports` and `Food` as menu items 1 and 2 on lines 37 and 38. Note that the length of the **Pick a topic** menu varies as `Vocab` objects are inserted and removed. However, the list of options on this dynamic menu always ends with the option 0 `Exit`, as shown on line 39.

```

41 Enter Your Choice: 1
42 -----
43         Pick a topic
44 -----
45 1 Sports
46 2 Food
47 0 Exit
48 -----
49 Enter Your Choice: 1
50 Topic: Sports
51 1: Hockey          2: ball          3: puck          4: racing
52 5: running         6: running shoes  7: tennis racket
53 -----
54         Pick a topic
55 -----
56 1 Sports
57 2 Food
58 0 Exit
59 -----
60 Enter Your Choice: 2
61 Topic: Food
62 1: Candy           2: burger          3: cheese        4: hot-dog
63 -----
64         Pick a topic
65 -----
66 1 Sports
67 2 Food
68 0 Exit
69 -----
70 Enter Your Choice:

```

- To browse the vocabulary list, we select 1 on line 41, and then pick topic 1 on line 49 followed by topic 2 on line 60.
  - Notice that the words associated with a topic are kept sorted by inserting new words each in their sorted positions. The topic names are not sorted.
- Choosing option 0 at line 71 will takes us back to the main menu where we select
  - option 2, inserting a new topic **Fruits** before the current top topic **Sports**, followed by
  - option 3, inserting a new topic named **Animals** after the current last topic **Food**:

```

71 Enter Your Choice: 0
72 -----
73     Vocabulary Control Center
74 -----
75 1  browse a topic
76 2  insert a new topic before another one
77 3  insert a new topic after another one
78 4  remove a topic
79 5  modify a topic
80 6  search topics for a word
81 7  load from a file
82 8  show all words starting with a given letter
83 9  save to file
84 0  exit
85 -----
86 Enter Your Choice: 2
87 -----
88     Pick a topic
89 -----
90 1  Sports
91 2  Food
92 0  Exit
93 -----
94 Enter Your Choice: 1
95 Enter a topic name:
96 Fruits
97 Enter a word - to quit press Enter:
98 apple
99 orange
100 banana
101 plum
102 melon
103 -----
104 -----
105     Vocabulary Control Center
106 -----
107 1  browse a topic
108 2  insert a new topic before another one
109 3  insert a new topic after another one
110 4  remove a topic
111 5  modify a topic
112 6  search topics for a word
113 7  load from a file
114 8  show all words starting with a given letter
115 9  save to file
116 0  exit
117 -----
118 Enter Your Choice: 3

```

```

119 -----
120     Pick a topic
121 -----
122 1  Fruits
123 2  Sports
124 3  Food
125 0  Exit
126 -----
127 Enter Your Choice: 3
128 Enter a topic name:
129 Animals
130 Enter a word - to quit press Enter:
131 cat
132 dog
133 horse
134 mouse
135 zebra
136 lion
137 -----
138 -----
139     Vocabulary Control Center
140 -----
141 1  browse a topic
142 2  insert a new topic before another one
143 3  insert a new topic after another one
144 4  remove a topic
145 5  modify a topic
146 6  search topics for a word
147 7  load from a file
148 8  show all words starting with a given letter
149 9  save to file
150 0  exit
151 -----
152 Enter Your Choice: 1
153 -----
154     Pick a topic
155 -----
156 1  Fruits
157 2  Sports
158 3  Food
159 4  Animals
160 0  Exit
161 -----
162 Enter Your Choice:

```

There are now 4 topics listed, but the program allows insertions and deletion of arbitrary number of **Vocab** objects.

Let us now browse the **Animals** and **Fruits** topics:

```

162 Enter Your Choice: 4
163 Topic: Animals
164 1: cat          2: dog          3: horse          4: lion
165 5: mouse        6: zebra
166 -----
167         Pick a topic
168 -----
169 1  Fruits
170 2  Sports
171 3  Food
172 4  Animals
173 0  Exit
174 -----
175 Enter Your Choice: 1
176 Topic: Fruits
177 1: apple        2: banana        3: melon          4: orange
178 5: plum
179 -----
180         Pick a topic
181 -----
182 1  Fruits
183 2  Sports
184 3  Food
185 4  Animals
186 0  Exit
187 -----
188 Enter Your Choice:

```

Let's remove the last topic [Animals](#):

```

188 Enter Your Choice: 0
189 -----
190     Vocabulary Control Center
191 -----
192 1  browse a topic
193 2  insert a new topic before another one
194 3  insert a new topic after another one
195 4  remove a topic
196 5  modify a topic
197 6  search topics for a word
198 7  load from a file
199 8  show all words starting with a given letter
200 9  save to file
201 0  exit
202 -----
203 Enter Your Choice: 4
204 -----
205         Pick a topic
206 -----
207 1  Fruits
208 2  Sports
209 3  Food
210 4  Animals
211 0  Exit
212 -----
213 Enter Your Choice: 4
214 -----

```

```

215     Vocabulary Control Center
216 -----
217 1  browse a topic
218 2  insert a new topic before another one
219 3  insert a new topic after another one
220 4  remove a topic
221 5  modify a topic
222 6  search topics for a word
223 7  load from a file
224 8  show all words starting with a given letter
225 9  save to file
226 0  exit
227 -----
228 Enter Your Choice: 1
229 -----
230         Pick a topic
231 -----
232 1  Fruits
233 2  Sports
234 3  Food
235 0  Exit
236 -----
237 Enter Your Choice:

```

We will now modify topics:

```
237 Enter Your Choice: 0
238 -----
239     Vocabulary Control Center
240 -----
241 1  browse a topic
242 2  insert a new topic before another one
243 3  insert a new topic after another one
244 4  remove a topic
245 5  modify a topic
246 6  search topics for a word
247 7  load from a file
248 8  show all words starting with a given letter
249 9  save to file
250 0  exit
251 -----
252 Enter Your Choice: 5
253 -----
254     Pick a topic
255 -----
256 1  Fruits
257 2  Sports
258 3  Food
259 0  Exit
260 -----
261 Enter Your Choice: 2
262 -----
263     Modify Topics Menu
264 -----
265 a  add a word
266 r  remove a word
267 c  change a word
268 0  Exit
269 -----
270 Enter Your Choice: a
271 Type a word and press Enter, or press Enter to end input
272 ball
273 sorry, the word: 'ball' is already listed
274 -----
275     Vocabulary Control Center
276 -----
277 1  browse a topic
278 2  insert a new topic before another one
279 3  insert a new topic after another one
280 4  remove a topic
281 5  modify a topic
282 6  search topics for a word
283 7  load from a file
284 8  show all words starting with a given letter
285 9  save to file
286 0  exit
287 -----
288 Enter Your Choice: 5
289 -----
290     Pick a topic
291 -----
292 1  Fruits
293 2  Sports
294 3  Food
295 0  Exit
296 -----
297 Enter Your Choice: 1
```

```
298 -----
299     Modify Topics Menu
300 -----
301 a  add a word
302 r  remove a word
303 c  change a word
304 0  Exit
305 -----
306 Enter Your Choice: a
307 Type a word and press Enter, or press Enter to end input
308 Strawberry
309 -----
310     Vocabulary Control Center
311 -----
312 1  browse a topic
313 2  insert a new topic before another one
314 3  insert a new topic after another one
315 4  remove a topic
316 5  modify a topic
317 6  search topics for a word
318 7  load from a file
319 8  show all words starting with a given letter
320 9  save to file
321 0  exit
322 -----
323 Enter Your Choice: 1
324 -----
325     Pick a topic
326 -----
327 1  Fruits
328 2  Sports
329 3  Food
330 0  Exit
331 -----
332 Enter Your Choice: 1
333 Topic: Fruits
334 1: Strawberry          2: apple          3: banana
335 5: orange             6: plum
336 -----
337     Pick a topic
338 -----
339 1  Fruits
340 2  Sports
341 3  Food
342 0  Exit
343 -----
344 Enter Your Choice: 2
345 Topic: Sports
346 1: Hockey             2: ball          3: puck
347 5: running            6: running shoes 7: tennis racket
348 -----
349     Pick a topic
350 -----
351 1  Fruits
352 2  Sports
353 3  Food
354 0  Exit
355 -----
356 Enter Your Choice: 0
357 -----
358     Vocabulary Control Center
359 -----
```



```

360 1 browse a topic
361 2 insert a new topic before another one
362 3 insert a new topic after another one
363 4 remove a topic
364 5 modify a topic
365 6 search topics for a word
366 7 load from a file
367 8 show all words starting with a given letter
368 9 save to file
369 0 exit
370 -----
371 Enter Your Choice: 5
372 -----
373         Pick a topic
374 -----
375 1 Fruits
376 2 Sports
377 3 Food
378 0 Exit
379 -----
380 Enter Your Choice: 3
381 -----
382         Modify Topics Menu
383 -----
384 a add a word
385 r remove a word
386 c change a word
387 0 Exit
388 -----
389 Enter Your Choice: r
390 Enter a word:
391 melon
392 sorry, there is no word: melon
393 -----
394         Vocabulary Control Center
395 -----
396 1 browse a topic
397 2 insert a new topic before another one
398 3 insert a new topic after another one
399 4 remove a topic
400 5 modify a topic
401 6 search topics for a word
402 7 load from a file
403 8 show all words starting with a given letter
404 9 save to file
405 0 exit
406 -----
407 Enter Your Choice: 1
408 -----
409         Pick a topic
410 -----
411 1 Fruits
412 2 Sports
413 3 Food
414 0 Exit
415 -----
416 Enter Your Choice: 3
417 Topic: Food
418 1: Candy          2: burger          3: cheese
419

```

```

420 -----
421         Pick a topic
422 -----
423 1 Fruits
424 2 Sports
425 3 Food
426 0 Exit
427 -----
428 Enter Your Choice: 0
429 -----
430         Vocabulary Control Center
431 -----
432 1 browse a topic
433 2 insert a new topic before another one
434 3 insert a new topic after another one
435 4 remove a topic
436 5 modify a topic
437 6 search topics for a word
438 7 load from a file
439 8 show all words starting with a given letter
440 9 save to file
441 0 exit
442 -----
443 Enter Your Choice: 5
444 -----
445         Pick a topic
446 -----
447 1 Fruits
448 2 Sports
449 3 Food
450 0 Exit
451 -----
452 Enter Your Choice: 3
453 -----
454         Modify Topics Menu
455 -----
456 a add a word
457 r remove a word
458 c change a word
459 0 Exit
460 -----
461 Enter Your Choice: r
462 Enter a word:
463 Candy
464 -----
465         Vocabulary Control Center
466 -----
467 1 browse a topic
468 2 insert a new topic before another one
469 3 insert a new topic after another one
470 4 remove a topic
471 5 modify a topic
472 6 search topics for a word
473 7 load from a file
474 8 show all words starting with a given letter
475 9 save to file
476 0 exit

```

4: hot-dog

```

477 -----
478 Enter Your Choice: 1
479 -----
480         Pick a topic
481 -----
482 1  Fruits
483 2  Sports
484 3  Food
485 0  Exit
486 -----
487 Enter Your Choice: 3
488 Topic: Food
489 1: burger          2: cheese          3: hot-dog
490 -----
491         Pick a topic
492 -----
493 1  Fruits
494 2  Sports
495 3  Food
496 0  Exit
497 -----
498 Enter Your Choice:
499 ...
500 ...

```

## 8 Evaluation Criteria for Assignment 3 (10 points)

Total	10 pts
JavaDoc documentations	1 pt
Proper implementation of the doubly linked list	2 pt
Proper implementation of the linked list	2 pt
Proper application of the <code>ArrayList</code> to creating sorted words beginning with the same letter	2 pt
Effective and user friendly user interface	2 pt
General Quality of the Assignment	1 pt

## 9 Inside the Input File

```
501 -----
502 Vocabulary Control Center
503 -----
504 1 browse a topic
505 2 insert a new topic before another one
506 3 insert a new topic after another one
507 4 remove a topic
508 5 modify a topic
509 6 search topics for a word
510 7 load from a file
511 8 show all words starting with a given letter
512 9 save to file
513 0 exit
514 -----
515 Enter Your Choice: 7
516 Enter the name of the input file:
517 A3_input_file.txt
518 Done loading
519 -----
520 Vocabulary Control Center
521 -----
522 1 browse a topic
523 2 insert a new topic before another one
524 3 insert a new topic after another one
525 4 remove a topic
526 5 modify a topic
527 6 search topics for a word
528 7 load from a file
529 8 show all words starting with a given letter
530 9 save to file
531 0 exit
532 -----
533 Enter Your Choice: 1
534 -----
535 Pick a topic
536 -----
537 1 Clothes and Accessories
538 2 Colours
539 3 Communications and Technology
540 4 Education
541 5 Entertainment and Media
542 0 Exit
543 -----
544 Enter Your Choice: 1
545 Topic: Clothes and Accessories
546 1: T-shirt          2: backpack          3: bag              4: belt
547 5: blouse           6: boot              7: bracelet        8: button
548 9: cap              10: chain            11: clothes        12: coat
549 13: collar          14: costume          15: cotton          16: dress
550 17: earring         18: fashion          19: fasten          20: fit(v)
551 21: fold(v)         22: glasses          23: glove           24: go(with/together)
552 25: handbag         26: handkerchief     27: hat             28: jacket
553 29: jeans           30: jewellery/jewelry 31: jumper          32: kit
554 33: knit            34: label            35: laundry         36: leather
555 37: make-up         38: match(v)         39: material        40: necklace
556 41: old-fashioned(adj) 42: pants           43: pattern         44: perfume
557 45: plastic         46: pocket           47: pullover        48: purse
558 49: put on          50: raincoat         51: ring            52: sandal
559 53: scarf           54: shirt            55: shoe            56: shorts
560 57: silk            58: size             59: skirt           60: sleeve(less)
561 61: socks           62: stripe           63: suit            64: sunglasses
562 65: sweater         66: sweatshirt       67: sweatshirt      68: swimming
563 69: swimsuit        70: take off         71: tie             72: tights
564 73: tracksuit       74: trainers         75: trousers        76: try on
565 77: umbrella        78: underpants       79: underwear       80: undress
566 81: uniform         82: wallet           83: watch           84: wear(out)
567 85: wool(len)
```

```

568 -----
569 Pick a topic
570 -----
571 1 Clothes and Accessories
572 2 Colours
573 3 Communications and Technology
574 4 Education
575 5 Entertainment and Media
576 0 Exit
577 -----
578 Enter Your Choice: 2
579 Topic: Colours
580 1: (dark/light/pale) 2: black 3: blue 4: brown
581 5: gold 6: golden 7: green 8: grey
582 9: orange 10: pink 11: purple 12: red
583 13: silver 14: white 15: yellow
584 -----
585 Pick a topic
586 -----
587 1 Clothes and Accessories
588 2 Colours
589 3 Communications and Technology
590 4 Education
591 5 Entertainment and Media
592 0 Exit
593 -----
594 Enter Your Choice: 3
595 Topic: Communications and Technology
596 1: (computer) 2: CD (player) 3: CD-Rom 4: DVD (player)
597 5: IT 6: MP3 7: PC 8: access
598 9: address 10: at!@ 11: blog 12: blogger
599 13: by post 14: call(v) 15: callback 16: camera
600 17: chat 18: chat 19: click(v) 20: computer
601 21: connect 22: connection 23: delete 24: dial
602 25: dial 26: digital 27: digital 28: disc/disk
603 29: dot 30: download(n&v) 31: drag 32: electronic(s)
604 33: email 34: engaged 35: enter 36: envelope
605 37: equipment 38: fax 39: file 40: hang
606 41: hardware 42: headline 43: homepage 44: install
607 45: internet 46: invent 47: invention 48: keyboard
608 49: laptop 50: machine 51: mat 52: message
609 53: mobile 54: mouse 55: mouse 56: net
610 57: online 58: operator 59: parcelcalculator 60: password
611 61: phone 62: phone 63: photograph 64: photography
612 65: player 66: postcard 67: print 68: printer
613 69: program(me) 70: reply 71: ring 72: ring up
614 73: room 74: screen 75: server 76: software
615 77: switch off 78: switch on 79: talk 80: telephone
616 81: text 82: text message 83: turn off 84: turn on
617 85: up 86: up 87: upload 88: video clip
618 89: volume 90: web 91: web page 92: webcam
619 93: website
620 -----
621 Pick a topic
622 -----
623 1 Clothes and Accessories
624 2 Colours
625 3 Communications and Technology
626 4 Education
627 5 Entertainment and Media
628 0 Exit
629 -----
630 Enter Your Choice: 4
631 Topic: Education
632 1: IT 2: absent 3: advanced 4: arithmetic
633 5: art 6: beginner 7: bell 8: biology
634 9: blackboard 10: board 11: board 12: book
635 13: bookshelf 14: break up 15: break(time) 16: certificate
636 17: chemistry 18: class 19: classroom 20: clever

```

637	21: coach	22: college	23: composition	24: course
638	25: curriculum	26: degree	27: desk	28: dictionary
639	29: diploma	30: drama	31: economics	32: elementary
640	33: essay	34: geography	35: handwriting	36: history
641	37: homework	38: information	39: instructions	40: instructor
642	41: intermediate	42: know	43: laboratory (lab)	44: language
643	45: learn	46: lesson	47: level	48: library
644	49: mark	50: math(s)	51: mathematics	52: music
645	53: nature	54: note	55: notice	56: pencil case
646	57: photography	58: physics	59: practice(n)	60: practise(v)
647	61: primary	62: project	63: pupil	64: qualification
648	65: read	66: register	67: remember	68: rubber
649	69: ruler	70: school	71: school	72: school
650	73: science	74: secondary	75: student	76: studies
651	77: studies	78: study(v)	79: subject	80: teach
652	81: teacher	82: technology	83: term	84: test
653	85: university			

654 -----  
 655 Pick a topic

656 -----  
 657 1 Clothes and Accessories  
 658 2 Colours  
 659 3 Communications and Technology  
 660 4 Education  
 661 5 Entertainment and Media  
 662 0 Exit  
 663 -----

664 Enter Your Choice: 5

665 Topic: Entertainment and Media

666	1: CD (player)	2: CD-Rom	3: MP3	4: act (v)
667	5: action	6: actor	7: actress	8: ad
668	9: admission	10: adventure	11: advert	12: advertisement
669	13: art	14: article	15: audience	16: ballet
670	17: band	18: board	19: book	20: camera
671	21: card	22: cartoon	23: celebrity DVD (player)	24: channel
672	25: chat	26: chess	27: cinema	28: circus
673	29: classical	30: comedy	31: comic	32: competition
674	33: concert	34: dance	35: dancer	36: disc
675	37: disc jockey	38: disco	39: display	40: documentary
676	41: drama	42: draw	43: drawing	44: entrance
677	45: exhibition	46: exit	47: festival	48: film
678	49: film	50: film	51: fireworks	52: folk
679	53: fun	54: game	55: go out	56: group
680	57: guitar	58: guitarist	59: headline	60: hero
681	61: heroine	62: hip	63: hit	64: hop
682	65: horror	66: instrument	67: interval	68: interview(er)
683	69: jazz	70: journalist	71: keyboard	72: laugh
684	73: listen to	74: look at	75: magazine	76: magic
685	77: maker	78: museum	79: music	80: music
686	81: music	82: music	83: music	84: musician
687	85: news	86: newspaper	87: opera	88: orchestra
688	89: paint	90: painter	91: perform	92: performance
689	93: performer	94: play	95: player	96: poem
690	97: pop	98: programme	99: quiz	100: recording
691	101: review	102: rock music	103: romantic	104: row
692	105: scene	106: show	107: soap opera	108: song
693	109: stage	110: star	111: talk show	112: television

694 -----  
 695 Pick a topic

696 -----  
 697 1 Clothes and Accessories  
 698 2 Colours  
 699 3 Communications and Technology  
 700 4 Education  
 701 5 Entertainment and Media  
 702 0 Exit  
 703 -----

704 Enter Your Choice: 6

```
706 option out of range, try again!
707 -----
708         Pick a topic
709 -----
710 1  Clothes and Accessories
711 2  Colours
712 3  Communications and Technology
713 4  Education
714 5  Entertainment and Media
715 0  Exit
716 -----
717 Enter Your Choice:
```