The dashundergaps package

Frank Mittelbach

Abstract

The dashundergaps package offers the possibility to replace material in running text with white space in order to build up forms that can be filled in at a later time. By default the gaps are underlined and followed by a gap number in parentheses, but many other designs are possible, e.g., dashes or dots instead of the underline, no gap numbers or a different format for them, gap widening for easier fill-in, etc. There is also a teacher’s mode which shows the normally hidden text in a special (customizable) format.

This is another article in a series of TUGboat articles describing small packages to introduce coding practices using the expl3 programming language. See [1] for the first article in the series. For more details on expl3 refer to [2].

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1 Introduction

The dashundergaps package provides a single command \gap which takes one argument and produces a gap of the width of that argument. To better mark this gap it is underlined in some form (could be a solid line, a dashed or dotted line or even a wriggling line). Furthermore, gaps can be numbered to be able to easily refer to them. Figure 1 shows an example in the form of a fill-in puzzle.

As you see there, some gaps are numbered with a superscript number (not the default setting) while others aren’t. How this is done and how to change the result is explained in the next section.

There also exists a “teacher mode” in which the gaps are filled with the text given in the argument. This can be used to show the correct answers of a test (as we do in

* This is a reimplementation (using expl3, the \LaTeX3 programming language) of a package originally written by Luca Merciadri in 2010. The current package version is v2.0g dated 2020-02-11.

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The initial ‘E.’ in Donald E. Knuth’s name stands for _____ (1). The well-known answer to the Ultimate Question is 42 according to ____ (2). The first edition of _____ (3) celebrates its silver anniversary in 2019. Historically speaking, expl3 stands for _____ (4) even though it is a production language these days.

And here are some hints for the puzzle if you want to fill it out:

1. If only everything would be that easy to answer.
3. Back then known as the doggie book.
4. Old names die hard.

The answers are given in Section 4, showing the gaps filled in using the so-called teacher mode, which can be activated or deactivated at any point in the document.

![Figure 1: A fill-in puzzle using dashundergaps](image)

Section 4) or to give a sample fill-in for a form, to help people fill it out correctly. The “teacher mode” produces the same line breaks because it ensures that the fill-ins take the same amount of space as the gaps.

Another important feature is the possibility to artificially widen the gaps, compared to the textual material in the argument. After all, when a form is filled by hand people typically need more space to write some text compared to the same text being typeset. So making the gaps simply as wide as the material likely results in too little space.

2 The user interface

The dashundergaps package is built as a small application on top of the ulem package, a package that defines several commands for underlining (simple-text) in various ways.

```
\uline{simple-text} \uwave{simple-text} ...
```

This means that by loading dashundergaps the ulem commands such as \uline, \uwave and so forth are automatically made available. These commands are used to do most of the work and the current package only makes sure that, instead of the words, empty boxes of the same width are used by ulem. This way we get underlined gaps of the right size.

By default, ulem changes \emph to underline text, so for this application, it is loaded with the option normalem to prevent that from happening.

```
\gap*[\style]{\text}
```

The main command provided by the package is \gap which expects a mandatory \text argument containing the material that is used to produce the gap (and is normally invisible). By default the gap is underlined, though that can be changed.

The optional \style argument explicitly defines a certain type of underlining: u stands for normal underlining (via \uline), d for double underlining (via \uuline), w for a wavy line (via \uwave), b for blank (i.e., no underlining whatsoever), “−” for a dash-line (via \dashuline) and finally “.” for underlining with dots (via \dotuline).

In the default configuration gaps are numbered using the counter gapnumber and this number is shown in parentheses after the gap. With the star form the generation of the

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number is toggled, i.e., if it would be produced because of the current option settings
it will be suppressed; if it is suppressed through an option it will be typeset. This way
one can select the most convenient setting via an option for the whole document and
use * to toggle it as needed.

Since \texttt{gap} uses \texttt{ulem}’s commands it inherits the limitations of these commands; notably,
only simple text can be used in the \texttt{(text)} argument. For example, a \texttt{footnote}
couldn’t be used in the argument (but then that wouldn’t make much sense in a gap, would it?).

Another important (and sometimes annoying) restriction is that any brace group
or command with arguments inside the \texttt{ulem} commands is set as if is is inside an
\texttt{mbox}, in particular it will not break across lines. For example \texttt{gap\{\textit{...}\}} will
show this behavior. The \texttt{dashundergaps} package tries mediate as best as possible, e.g.,
\texttt{gap\{\textit{mytext}\}} works, but in other cases you have to live with this limitation.

\begin{verbatim}
\TeacherModeOn \TeacherModeOff
\TeacherModeOn % show gap material
\TeacherModeOff % do not show gap material
\end{verbatim}

Also supported is a teacher mode in which the material for the gaps is visible. This can
be used to show the expected answers in case \texttt{gap} is used for preparing tests, or to
show a sample fill-in of a form. The teacher mode can be turned on or off anywhere in
the document using \texttt{\TeacherModeOn} or \texttt{\TeacherModeOff}, respectively. Alternatively,
it can also be set via an option, as we will see below.

\begin{verbatim}
\dashundergapssetup{(comma-separated key-value list)}
\end{verbatim}

The package can be loaded with a number of options (discussed in Section 2.1). A
likely better approach is to set any options with the declaration \texttt{\dashundergapssetup}
which is normally used in the preamble, but can be used throughout the document to
change settings on the fly. It only changes explicitly given options so it can be used to
overwrite some defaults but leave everything else unchanged.

\section{Options to customize the gap display}

All of the package options are implemented as key/value options. For boolean options
one can give just the option name as a short form for setting the option to \texttt{true}. Most
options can be specified during package loading in the optional argument of \texttt{\usepackage}.
However if the value requires some \LaTeX{} code (e.g., \texttt{gap-font}, which
expects a font declaration command) then this will not work due to some limitations in
the current \LaTeX{} package loader. For such options use \texttt{\dashundergapssetup} instead,
which will always work.

\subsection{Gap modes}

The general processing mode is defined through the following options:

\texttt{\texttt{teacher-mode}} Boolean that turns on teacher mode (i.e., the gap material will
be visible if set to \texttt{true}). Its default is \texttt{false}.

\texttt{\texttt{gap-mode}} Boolean that is the inverse of \texttt{teacher-mode} and just provided for conve-
nience, i.e., an abbreviation for \texttt{teacher-mode=false}.

\texttt{\texttt{teachermode}} Alternative name for \texttt{teacher-mode} because that is what it was called
in the first package release.

\subsection{Gap formatting}

Formatting of the gaps is handled by the following six options:

\texttt{\texttt{gap-format}} A choice option defining how the gap is marked. It accepts the following
values: \texttt{underline} (default), \texttt{double-underline}, \texttt{dash}, \texttt{dot}, \texttt{wave}, \texttt{blank}.

The \texttt{dashundergaps} package
gap-format-adjust A boolean (default true). If set, the “line” below the gap is raised to be roughly at the baseline, which normally looks better when there is no text above the line.

teacher-gap-format Another choice option, with the same values as gap-format, used when we are in “teacher mode”, but this time the default is blank as normally the gap text is typeset in the bold font and is therefore already identifiable, with no need for additional underlining. However, depending on the circumstances it might be helpful to keep the underlining (or use a different kind of underlining) while in “teacher mode”.

gap-font This option expects a font directive as its value, e.g., \bfseries (which is also the default). Using this option without supplying a value is equivalent to supplying an empty value. It will be used to determine the font for the gap material regardless of the mode. This is important to ensure that the gaps always have the same width regardless of whether or not the material is shown.

For the example puzzle above it was set to \itshape, which you can see in the puzzle answer.

dash Short name for gap-format=dash.

dot Short name for gap-format=dot.

2.1.3 Gap numbers

Producing the gap numbers is handled by the following options:

gap-numbers Boolean that determines whether or not gap numbers are displayed. Default is true.

gap-number-format Code that is executed when a gap number is produced. Default is \textnormal{/uni2423(\thegapnumber)}.

numbers Short name for gap-numbers.

There is also a way to control displaying the total number of gaps:

display-total-gaps Boolean to determine if the total number of gaps should be shown at the very end of the document. Default is false.

displaytotalgaps This is just another name for the same boolean; it was used in the first version of the package.

2.1.4 Gap widening

Finally, for extending the gap width we have these options:

gap-widen Boolean that decides if the gaps should be made wider or not (default is false but mainly for historical reasons).

gap-extend-minimum Minimum of extra space that should be added to each gap if gap widening is active. Default is 20pt, i.e., 10pt on either side.

gap-extend-percent Percentage (as a number) by which the gap should be made wider if widening is active. The result is compared to gap-extend-minimum and the larger of the two is used. Default is 20.

widen Short name for gap-widen.

3 Differences from the original package

The main user interface of the two versions is identical, so it is possible to use the new version as a drop-in replacement for the old. However, the feature set in form of key/value options has been greatly extended, offering functionality previously unavailable. Furthermore, a number of bugs have been corrected (and possibly new ones introduced).

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• Stray spaces in the definition of \texttt{\gap} (that showed up in the output) have been eliminated.
• Various combinations of options that didn’t work are now possible.
• Explicit hyphenations -- showed up in gap mode, now they can be used.
• Nesting isn’t possible for obvious reasons, but the fact is now detected and catered to by ignoring the inner gap requests after generating an error.
• Option names have been normalized (though the original names are still available).
• The option \texttt{phantomtext} is no longer necessary, though still supported (with a warning) as a no-op.
• The names of the \LaTeX\ counters used have changed, so if you directly addressed them that would need changing.
• The font used in teacher mode (by default boldface) is now also used if gap mode is chosen, to ensure that the output in all modes produces identical line breaks; for the same reason, the \texttt{ulem} machinery is always used, even if not underlining (or dashing, etc.).
• The gaps can be extended by a percentage or by a minimum amount to ensure that there is enough space to fill in the text (given that hand-written text is typically wider than typeset material); the values are adjustable.
• \texttt{\gap} now has an optional argument through which you can explicitly request the type of underlining you want to use.
• \texttt{\gap} also supports a star form which toggles the setting of gap numbers.
• The use of \texttt{\label} within the \texttt{\gap} command argument allows for later reference to that gap by its number (provided a gap number is typeset).
• The implementation is done with \texttt{expl3}, the programming language for \LaTeX3. Although invisible to the user, in some sense that was the main purpose of the exercise: to see how easy it is to convert a package and use the extended features of \texttt{expl3}.

4 Solution to the puzzle

Here we repeat the puzzle from above with \texttt{\TeacherModeOn}.

The initial ‘E’ in Donald E. Knuth’s name stands for \texttt{Ervin} \textsuperscript{(5)}. The well-known answer to the Ultimate Question \texttt{of Life, the Universe, and Everything} is 42 according to \texttt{Douglas Adams} \textsuperscript{(6)}. The first edition of \texttt{The \LaTeX\ Companion} \textsuperscript{(7)} celebrates its silver anniversary in 2019. Historically speaking, \texttt{expl3} stands for \texttt{EXperimental Programming Language 3} \textsuperscript{(8)} even though it is a production language these days.

This was produced using the following changes to the defaults:

\begin{verbatim}
\dashundergapssetup{
    ,gap-number-format = \textsuperscript{\texttt{\normalfont (\thegapnumber)}}
    ,gap-font = \texttt{\itshape}
    ,teacher-gap-format = underline
    ,gap-widen
}
\end{verbatim}

As you can see we use \texttt{\itshape} for the font (to be able to show the bold face in one of the answers) and also force underlining in teacher mode to better show the gap widening. The gap number is raised and we separate it a tiny bit from the gap material. We also use \texttt{\normalfont} in the formatting to ensure that the gap number is set upright and not in italic shape.

The \texttt{dashundergaps} package
5 The implementation

5.1 Loading and fixing/changing ulem

The first thing to do is to load ulem without changing \textit{or} \textbf{em}:

\begin{verbatim}
\NeedsTeXFormat{LaTeX2e}
\usepackage[normalem]{ulem}
\end{verbatim}

The code in this section follows \LaTeX{} conventions, i.e., models the commands as they look in the ulem package.

\texttt{\textbackslash dotu}{\texttt{linese}} The dots produced by \texttt{\textbackslash dotuline} depend on the current font, which is a somewhat questionable design—if you underline a text with a single bold word somewhere inside it will change the shape of the dot line. So we always use the \texttt{\textbackslash normalfont} dot (this is not done in the original definition).

\begin{verbatim}
\protected\def\dotuline\leavevmode\bgroup
  \UL@setULdepth
  \ifx\UL@on\UL@onin\advance\ULdepth2\p@\fi
  \markoverwith{\begingroup
    \advance\ULdepth0.08ex
    \lower\ULdepth\hbox{\normalfont .\kern.04em}\
  \endgroup}\
\ULon}
\end{verbatim}

(End definition for \texttt{\textbackslash dotuline}. This function is documented on page 2.)

\texttt{\textbackslash uwave} The original \texttt{\textbackslash uwave} used a hard-wired value of 3.5pt for the lowering. We change that to be based on the current value of \texttt{\textbackslash ULdepth} so that the user (or this package here) can change the placement.

\begin{verbatim}
\protected\def\uwave\leavevmode\bgroup
  \UL@setULdepth
  \advance\ULdepth0.6\p@
  \markoverwith{\lower\ULdepth\hbox{\sixly \char58}}\ULon}
\end{verbatim}

(End definition for \texttt{\textbackslash uwave}. This function is documented on page 2.)

\texttt{\textbackslash fmdug@ublank} \texttt{\textbackslash fmdug@ublank} underlines with blanks. Normally not especially useful (which is why we make it internal), but if we want to have ulem acting, but without actually visibly underlining, this is the command to use.

\begin{verbatim}
\def\fmdug@ublank\bgroup\let\UL@leadtype\@empty\ULon\endgroup
\end{verbatim}

(End definition for \texttt{\textbackslash fmdug@ublank}.)

\texttt{\textbackslash UL@dischyp} \texttt{\textbackslash UL@putbox} We need to do a little patching to ensure that nothing is output by the ulem commands if we don’t want it to. So the next two commands are from ulem with \texttt{\textbackslash box} replaced by \texttt{\textbackslash fmdug@box} so that we can change the behavior.

\begin{verbatim}
\def\UL@dischyp\global\setbox\UL@hyphenbox\hbox
  {\ifnum \hyphenchar\font<\z@ \string- \else \char\hyphenchar\font \fi}\
\kern\wd\UL@hyphenbox \UL@penalty\@M
\UL@stop \kern-\wd\UL@hyphenbox \\
\discretionary{\fmdug@box\UL@hyphenbox}{\fmdug@box\UL@hyphenbox}{}\UL@start}
\def\UL@putbox\ifx\UL@start\@empty \else \% not inner
  \vrule\@width\z@ \UL@penalty\@M
\fi\ UL@skip\wd\UL@box \UL@leaders \kern-\UL@skip%}
\fmdug@box\UL@box \fi}
\end{verbatim}

(End definition for \texttt{\textbackslash UL@dischyp} and \texttt{\textbackslash UL@putbox}.)

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\fmdug@box  By default we output the box in the commands above, but when we don’t want to output anything visible we change the definition to generate a box with empty content but the right size.
26 \let\fmdug@box\box
(End definition for \fmdug@box.)

5.2 The main implementation part
The rest of the package is written in expl3. We use fmdug as our internal prefix.
(\@=fmdug)
We need the package xparse for specifying the document-level interface commands
and l3keys2e to use the expl3 key value methods within\TeX. These packages
automatically require expl3 so there is no need to load that explicitly.
27 \RequirePackage{xparse,l3keys2e}
As the code uses some functions from expl3 that got introduced sometime in 2018 we
need to require a fairly recent version (the date is somewhat arbitrarily picked).
28 \@ifpackagelater{expl3}{2018-06-24}
29 \%
30 \PackageError{dashundergaps}{Support package l3kernel too old}
31 \%
32 Please install an up to date version of l3kernel\MessageBreak
33 using your TeX package manager or from CTAN.\MessageBreak
34 \MessageBreak
35 Loading dashundergaps will abort!%
36 }
37 \endinput
\%
}
Here we introduce the package and specify its version number:
40 \ProvidesExplPackage{dashundergaps}
41 {\dashundergapsdate}
42 {\dashundergapsversion}
43 {Dashing and underlining phantom text}

5.2.1 User interface commands
\gap  The \gap command parses for a star, optional and mandatory argument and then calls
\_\_fmdug\_gap:nnn to do the work.
44 \DeclareDocumentCommand \gap { som }
45 {\%
We try to expand as much as possible up front to avoid the ulem limitations:
46 \protected@edef\next{#3}
47 Use the “content” of \next in the processing:
48 \_\_fmdug\_gap:nno (#1){#2}{ \next }
(End definition for \gap. This function is documented on page 2.)
\dashundergapssetup  Change options anywhere.
46 \NewDocumentCommand \dashundergapssetup { m }
47 { \keys_set:nn {fmdug} {#1} \ignorespaces }
(End definition for \dashundergapssetup. This function is documented on page 3.)

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We provide shortcuts for turning teacher mode on or off.

\TeacherModeOn
\TeacherModeOff
\DeclareDocumentCommand \TeacherModeOn {} {
\bool_set_true:N \l__fmdug_teacher_bool }
\DeclareDocumentCommand \TeacherModeOff {} {
\bool_set_false:N \l__fmdug_teacher_bool }

(End definition for \TeacherModeOn and \TeacherModeOff. These functions are documented on page 3.)

5.2.2 Counters

\c@gapnumber We have one user-level counter which is referenceable and holds the gap number of the current gap. It can be reset to 0 to restart counting.
\newcounter{gapnumber}

(End definition for \c@gapnumber.)

\c@totalgapnumber We also keep track of all gaps ever made using another user-level counter. Since this one is supposed to keep track of the total number of gaps, it makes little sense to modify it at the document level. However, there may be use cases even for that and more importantly, by making it a user-level counter it is possible to refer to the total number of gaps easily, e.g., via \thetotalgapnumber.
\newcounter{totalgapnumber}

(End definition for \c@totalgapnumber.)

\l__fmdug_extend_dim A help register to calculate the gap width later on.
\dim_new:N \l__fmdug_extend_dim

(End definition for \l__fmdug_extend_dim.)

\l__fmdug_extra_left_gap_tl \l__fmdug_extra_right_gap_tl Two scratch token lists to enlarge the gap on the left or right side.
\tl_new:N \l__fmdug_extra_left_gap_tl
\tl_new:N \l__fmdug_extra_right_gap_tl

(End definition for \l__fmdug_extra_left_gap_tl and \l__fmdug_extra_right_gap_tl.)

\l__fmdug_gap_format_tl \l__fmdug_teacher_gap_format_tl The gap formatting is normally handled by a \ulem command; which one depends on the options used. To record the choice we store it in a token list (one for normal and one for teacher mode).
\tl_new:N \l__fmdug_gap_format_tl
\tl_new:N \l__fmdug_teacher_gap_format_tl

(End definition for \l__fmdug_gap_format_tl and \l__fmdug_teacher_gap_format_tl.)

5.2.3 Messages

\msg_new:nnn {dashundergaps} {deprecated}
{ The- #1- ' #2'- you- used- \msg_line_context: \ is- deprecated- and- there- is- no- replacement.- Since- I- will- not- guarantee- that- #1- ' #2'- will- be- kept- forever- I- strongly- encourage- you- to- remove- it- from- your- document. }
\msg_new:nnnn {dashundergaps} {nested}
{ The- \gap command- can’t- be- nested! }
\msg_new:nnnn {dashundergaps} {gap-format-value}
{ Unknown- value- for- key- ’ #1 gap-format’! }

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5.2.4 Option handling

Here we define all the possible option keys for use either as package options or inside `\dashundergapssetup`. These are all straightforward assignments to variables. These internal variables are declared by the key declarations if unknown, so they are not separately declared beforehand.

\keys_define:nn {fmdug}

\begin{verbatim}
\% ====================================
,teacher-mode .bool_set:N = \l__fmdug_teacher_bool
,teacher-mode .default:n = true
,teacher-mode .initial:n = false
\% ------------------
,gap-mode .bool_set_inverse:N = \l__fmdug_teacher_bool
\% ====================================
,gap-format .choice:
\end{verbatim}

In the case of dashes and even more so in the case of dots, it looks fairly ugly if they are below the baseline as if there were text above. We therefore raise them up a bit if the option `gap-format-adjust` is given (which is the default).

In the case of dots we undo exactly the amount by which they are lowered in `ulem` so that they end up precisely at the baseline, in case they are followed by a real dot. In other cases we stay a bit below the baseline.

The same is done below when the optional argument is evaluated. But we don’t do this in teacher mode since there we will have text above and we don’t want to bump into that.

\begin{verbatim}
\% gap-format / underline
,code:n = \tl_set:Nn \l__fmdug_gap_format_tl \__fmdug_gap_format_adjust:n{.4pt} \uline
\% gap-format / double-underline
,code:n = \tl_set:Nn \l__fmdug_gap_format_tl \__fmdug_gap_format_adjust:n{2pt} \uuline
\% gap-format / dash
,code:n = \tl_set:Nn \l__fmdug_gap_format_tl \__fmdug_gap_format_adjust:n{0pt} \dashuline
\% gap-format / dot
,code:n = \tl_set:Nn \l__fmdug_gap_format_tl \__fmdug_gap_format_adjust:n{-08ex} \dotuline
\% gap-format / wave
,code:n = \tl_set:Nn \l__fmdug_gap_format_tl \__fmdug_gap_format_adjust:n{1pt} \uwave
\% gap-format / blank
,code:n = \tl_set:Nn \l__fmdug_gap_format_tl \fmdug@ublank
\% gap-format / unknown
,code:n = \msg_error:nnn{dashundergaps}{gap-format-value}{}
\% gap-format
,initial:n = underline
\% ====================================
\end{verbatim}

This controls the raising of the gap underline by some amount. We implement it as a `.choice` even though it looks like a boolean.

\begin{verbatim}
\% gap-format-adjust
,choice:
\% gap-format-adjust / true
\end{verbatim}

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\code:n = \cs_set:Npn \_fmdug_gap_format_adjust:n ##1
\{ \setlength\ULdepth {##1} \}
gap-format-adjust / false
\code:n = \cs_set_eq:NN \_fmdug_gap_format_adjust:n \use_none:n
gap-format-adjust
.default:n = true
gap-format-adjust
.initial:n = true
.adjust .meta:n = { gap-format-adjust }
\%
===================================
teacher-gap-format
.choice:
teacher-gap-format / underline
\code:n = \tl_set:Nn \l__fmdug_teacher_gap_format_tl { \uline }
teacher-gap-format / double-underline
\code:n = \tl_set:Nn \l__fmdug_teacher_gap_format_tl { \uuline }
teacher-gap-format / dash
\code:n = \tl_set:Nn \l__fmdug_teacher_gap_format_tl { \dashuline }
teacher-gap-format / dot
\code:n = \tl_set:Nn \l__fmdug_teacher_gap_format_tl { \dotuline }
teacher-gap-format / wave
\code:n = \tl_set:Nn \l__fmdug_teacher_gap_format_tl { \uwave }
teacher-gap-format / blank
\code:n = \tl_set:Nn \l__fmdug_teacher_gap_format_tl { \fmdug@ublank }
teacher-gap-format / unknown
\code:n = \msg_error:nnn{dashundergaps}{gap-format-value}{teacher-}
teacher-gap-format
.initial:n = blank
\%
===================================
gap-widen .bool_set:N = \l__fmdug_gap_widen_bool
gap-widen .default:n = true
gap-widen .initial:n = false
\%
--------------
gap-extend-minimum .dim_set:N = \l__fmdug_gap_min_dim
gap-extend-minimum .initial:n = 20pt
\%
--------------
gap-extend-percent .tl_set:N = \l__fmdug_gap_percent_tl
gap-extend-percent .initial:n = 20
\%
===================================
gap-numbers .bool_set:N = \l__fmdug_number_bool
gap-numbers .default:n = true
gap-numbers .initial:n = true
\%
--------------
gap-number-format .tl_set:N = \l__fmdug_gapnum_format_tl
gap-number-format .initial:n = \textnormal{\space (\thegapnumber)}
\%
===================================
display-total-gaps .bool_gset:N = \g__fmdug_display_total_gaps_bool
display-total-gaps .default:n = true
display-total-gaps .initial:n = false
\%
===================================
gap-font .tl_set:N = \l__fmdug_font_tl
gap-font .default:n = \bfseries
gap-font .initial:n = \bfseries

And finally the original options, now as aliases:
At last, here comes the action. \_\_fmdug_gap:nn expects three arguments: \texttt{#1} identifies if a star was present, \texttt{#2} indicates what kind of “underlining” is wanted (anything not recognized is ignored, in particular “–NoValue–” if \texttt{gap} was used without an optional argument) and \texttt{#3} is the material to produce a gap for.

\begin{verbatim}
\cs_new:Npn \_\_fmdug_gap:nnn #1#2#3 {
\group_begin:
\l__fmdug_font_tl \Define the font used inside the gap. We need to do this up front since we want to measure the text (and that needs the correct font already).
\end{verbatim}

Nesting is not supported so inside the gap we redefine \_\_fmdug_gap:nnn to raise an error and just return the third argument if it is encountered again.

\begin{verbatim}
\cs_set:Npn \_\_fmdug_gap:nnn ##1##2##3 {
\msg_error:nn{dashundergaps}{nested}
##3
}
\end{verbatim}

We always increment the counter for the total number of gaps, but increment the \texttt{gapnumber} only if we are displaying it. For the latter one we use \texttt{\refstepcounter} to make it referenceable.

\begin{verbatim}
\stepcounter{totalgapnumber}
\bool_xor:nnT { #1 } { \l__fmdug_number_bool }
{ \refstepcounter{gapnumber} }
\end{verbatim}

Next we prepare for widening if that is being asked for: Measure the width of the text and then set \texttt{\l__fmdug_extend_dim} to be the requested percentage divided by two of that width (since we add it later on both sides).

\begin{verbatim}
\bool_if:NTF \l__fmdug_gap_widen_bool {
\settowidth {\l__fmdug_extend_dim}{#3}
\dim_set:Nn \l__fmdug_extend_dim { \l__fmdug_gap_percent_tl \l__fmdug_extend_dim / 200 }
\end{verbatim}

Then compare it to the minimum / 2 and choose whatever is larger.

\begin{verbatim}
\dim_compare:nNnT \l__fmdug_extend_dim < { .5\l__fmdug_gap_min_dim } {
\dim_set:Nn \l__fmdug_extend_dim { .5\l__fmdug_gap_min_dim }
}
\end{verbatim}

Now we prepare what needs to go to the left and the right of the gap.

\begin{verbatim}
\tl_set:Nn \l__fmdug_extra_left_gap_tl \hbox_to_wd:nn{\l__fmdug_extend_dim}{allowbreak }
\tl_set:Nn \l__fmdug_extra_right_gap_tl \hbox_to_wd:nn{\l__fmdug_extend_dim}{allowbreak }
\end{verbatim}

The \texttt{dashundergaps} package
And if no widening is asked for we clear these two token lists so they don’t do anything.

\{\tl_clear:N \l__fmdug_extra_left_gap_tl\}
\{\tl_clear:N \l__fmdug_extra_right_gap_tl\}

Next comes deciding the gap format. If in teacher mode it will be whatever is in \l__fmdug_teacher_gap_tl. Otherwise, either it is based on the content of the optional argument or, if that is not given or unknown, it will be \l__fmdug_gap_format_tl.

\bool_if:NTF \l__fmdug_teacher_bool {
\l__fmdug_teacher_gap_format_tl
}{

But before we execute any of the ulem commands we make sure that they do not output text.

\cs_set:Npn \fmdug@box ##1 {\hbox_to_wd:nn{\box_wd:N ##1}{}}
\str_case:nnF {#2} {
\{u\} { \__fmdug_gap_format_adjust:n{.4pt} \uline }
\{d\} { \__fmdug_gap_format_adjust:n{2pt} \uuline }
\{w\} { \__fmdug_gap_format_adjust:n{1pt} \uwave }
\{b\} { \fmdug@ublank }
\{.\} { \__fmdug_gap_format_adjust:n{-.08ex} \dotuline }
\{-\} { \__fmdug_gap_format_adjust:n{0pt} \dashuline }
}\}
\{ \l__fmdug_gap_format_tl \}

Whatever was decided as the gap format, it needs one argument, i.e., the material (with possible gap extension on both sides).

{\l__fmdug_extra_left_gap_tl #3 \l__fmdug_extra_right_gap_tl }

Finally we typeset the gap number if that was requested.

\bool_xor:nnT { #1 } { \l__fmdug_number_bool }
\{ \l__fmdug_gapnum_format_tl \}

Close the group from above to keep any of the redefinitions confined.

\group_end:
\}
\cs_generate_variant:Nn \__fmdug_gap:nnn {nno}
(End definition for \__fmdug_gap:nnn.)

\__fmdug_display_total_gaps: This command will display the total number of gaps if requested. The hard-wired formatting comes from the first version of the package.

\cs_new:Npn \__fmdug_display_total_gaps: { \vfill \centering \bfseries Total- Gaps:- \thetotalgapnumber }
(End definition for \__fmdug_display_total_gaps:)

5.2.5 Closing shop
At the end of the document we typeset the total number of gaps if requested.

\AtEndDocument{
\bool_if:NT \g__fmdug_display_total_gaps_bool
\l__fmdug_display_total_gaps:
}

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So what remains to be done is executing all options passed to the package via \
\usepackage. 
\ProcessKeysPackageOptions{fmdug} 
\endinput

References
https://ctan.org/pkg/widows-and-orphans
https://latex-project.org/publications/indexbytopic/l3-expl3/

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https://www.latex-project.org
https://ctan.org/pkg/dashundergaps

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