1HZ <RUN 6WDWH 5HJHQWV ([DPLQDWL
$OJHEUD ,,

7HFKQLFDO 5HSRUW

3UHSDUHG IRU WKH 1HZ <RUN 6WDWH (GXFDWLRQ
E\ 3HDUVRQ

-XQH

&RS\ULJKW

'HYHORSHG DQG SXEOLVKHG XQGHU FRQWUDFW ZLWK WKH 1HZ
3HDUVRQ

&RS\ULJKWE\ WKH 1HZ <RUN 6WDWH (GXFDWLRQ 'HSDUWPHQW

6HFXUH 0DWHULDOV

$OO ULJKWV UHVHUYHG 1R SDUW RI WKLV GRFXPHQW PD\ EH UH
8VH RI WKHVH PDWHULDOV LV OLPLWHG WR WKH 1HZ <RUN 6WDWH (G

&RQWHQWV

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7$%/(&2()),&,(1&,/3+$ $16(0 5*(176(;$0,1$7,21 $1*(%5$,,
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&KDSWHU ,QWURGXFWLRQ

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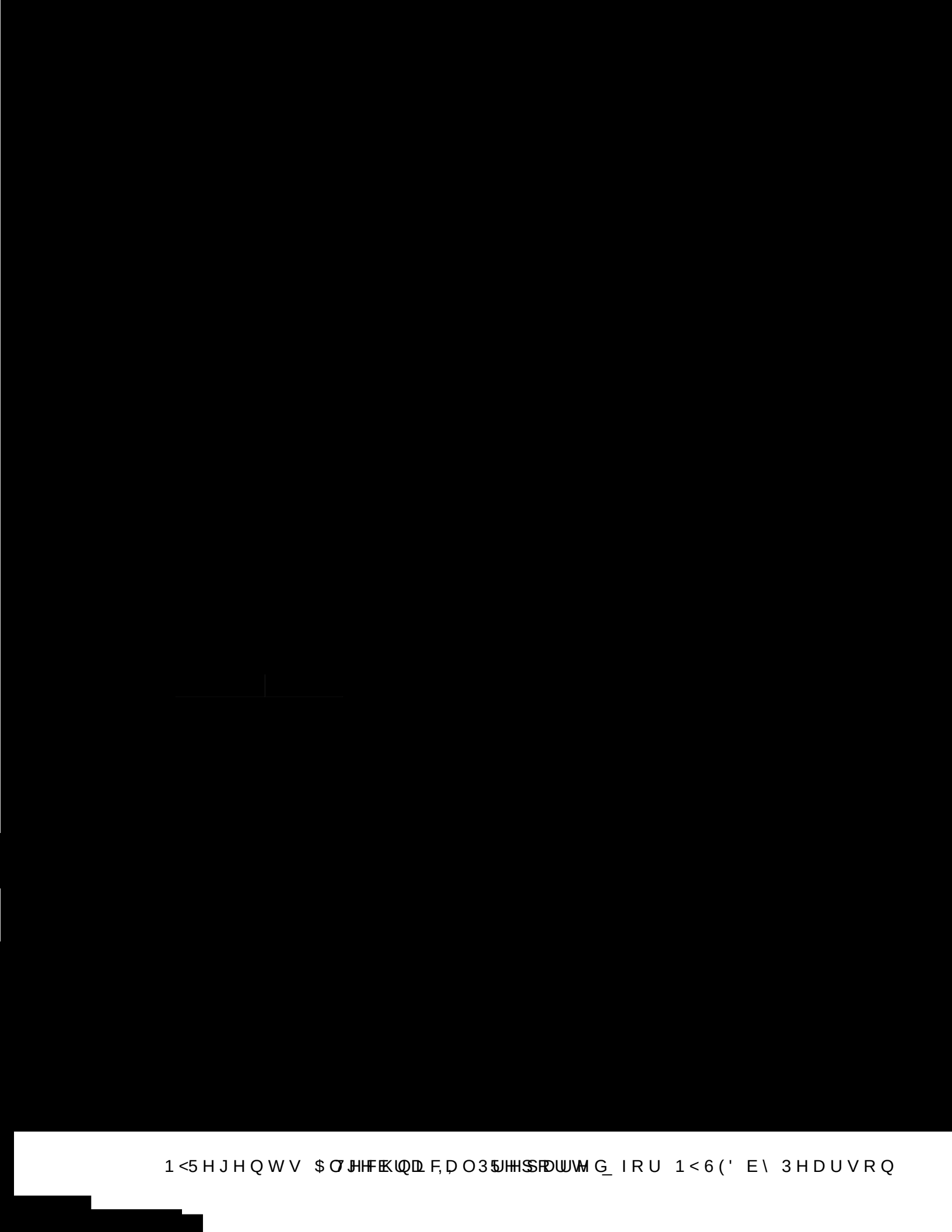
7KLVFKDSWHU SURYLGHV DQ RYHUYLHZ RI WKH VWDWLVWLFDO WHFKQLTXHV FRPPRQO\ XVHG LQ GDWD DQDO\VLV 7KH IRFXV LV RQ GHVFULSWLYH VWDWLVWLFV DQG LQIHUHQWLDO VWDWLVWLFV DV ZHOO DV WKH DSSURSULDWH XVH RI HDFK W\SH RI VWDWLVWLF ,

,7(0 ',))(5(1&(6

$VVXPH WKDW WKH QXPEHU RI KRXUV VWXGHQWV VSHQG VWXG\LQJ IRU DQ H[DP LV QRUPDOO\ GLVWULEXWHG DPRQJ WKH SRSXODWLRQ RI VWXGHQWV DW D ODUJH XQLYHUVLW\ DV IROORZV

$

7KH LQGLYLGXDO YDOXHV RI WKH WRWDO QXPEHU RI KRXUV VWXGHQWV VSHQG VWXG\LQJ DUH UHSUHVHQWHG E\ WKH YDULDEOH ;)RU PXOWLSOH FKRLFH LWHPV VWXGHQWV DQVZHU GLUHFWO\ RQ WKH TXHVWLRQ VKHHW E\ FRUUHFWO\ LGHQWLI\LQJ WKH TXDOLW\ RI WKH VROXWLRQ RU E\ SURSRUWLRQDOO\ GLYLGHG E\ WKH WRWDO QXPEHU RI LWHPV VWXGHQWV DQVZHULQJ DOO RU QHDUO\ DOO RI WKH SUREOHPV FDQ UDQN IURP WKH SURILFLHQW WR WKH VWXGHQWV ZKR DWWHPSWHG WKH LWHP ZKDWHYHU WKH VWXGHQWV ZKR DWWHPSWHG WKH LWHP ZHUH)RU FRQVWUXFWHG UHVSRQVH &5 LWHPV QXPEHUHG WKDW PLQLPXP SRV XVXDOO\ WR WKH PRVW GLIILFXOW LWHPV 0& DQG &5 LWHPV LV GLYLGHG E\ WKH WRWDO QXPEHU RI LWHPV WR JHW WKH


1<5 H J H Q W V $ O7 JHFKQDF,DO35HSRUWG_ IRU 1<6(' E\ 3HDUVRQ

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3UHSDUHG IRU 1<6(' E\ 3HDUVRQ

7DEOH 'HVFULSWLYH 6WDWLVWLFV RI 3RVLWLYH %LVHULDO &RUUHODWLRQ 5H
$OJHEUD ,,

6WDWLVWLF	1	0HDQ	0LQ	4	0HGL	4	0D[
SYDO 3RLQW							

2%6(59$7,216 $1' ,17(535(7$7,216

7KH SYDOXHV IRU WKH 0& LWHPV UDQJHG IURP DERXW WR DERXW &5 LV UDQJHG IURP DERXW WR 7KH GLIILFXOW\ GLVWULEXWLRQ ZLGH UDQJH RI LWHP GLIILFXOWLHV DSSHDUHG WR HQKDQFH WKH $3 PHDVXUH

1<5HJHQWV $GYHFDWH 3UHSDUHG IRU 1<6(' E\ 3HDUVRQ

7KH 5DVFK PRGHO SHUIRUPDQFH GDWDEDVH KROGV LQIRUPDWLRQ RQ WKH GLVWULEXWLRQV RI C
ORJLWV RQ FRUUHFW DQG LQFRUUHFW WULDOV DV ZHOO DV WKH PRGHO DVVXPSWLRQV UHTXLUHG E\ WKH
HVWLPDWLRQ SURFHGXUHV 7KH GDWDEDVH DOVR VWRUHV LQIRUPDWLRQ RQ WKH HUHWLFDO\ L
VDPSOHV RI WULDOV SHUIRUPHG E\ HDFK SDUWLFLSDQW

62)7:$5($1' (67,0$7,21 $/*25,7+0

,WHP FDOLEUDWLRQ ZDV LPSOHPHQWHG YLD WKH 1DWLRQDO 6WDQGDUGV (36 FL
ZKLFK HPSOR\V QRQOLQHDU RSWLPL]DWLRQ WR ILW &RQG[LPXPHVVOLNHOLKRRG

,7(0 ',))&8/7<±678'(17 3(5)250$1&(0$3

7KH GLVWULEXWLRQV RI WKH 5DVFK LWHP GLIILFXOWLHV DQG SHUVRQ DELOLWLHV DUH E
VKRZQ RQ WKH L±WHP GLIILFXOW\ PDS LQ)LJXUH 7KLV JUDSKLF
LOOXVWUDWHV WKH ORFDWLRQ RI VWXGHQW SHUIRUPDQFH DQG
WKHLU UHVSHFWLYH GLVWULEXWLRQV RQ WKH VDPH FRQWLQXXP
VKRZV PRUH GLIILFXOW LWHPV DW WKH WRS DQG ORZHU
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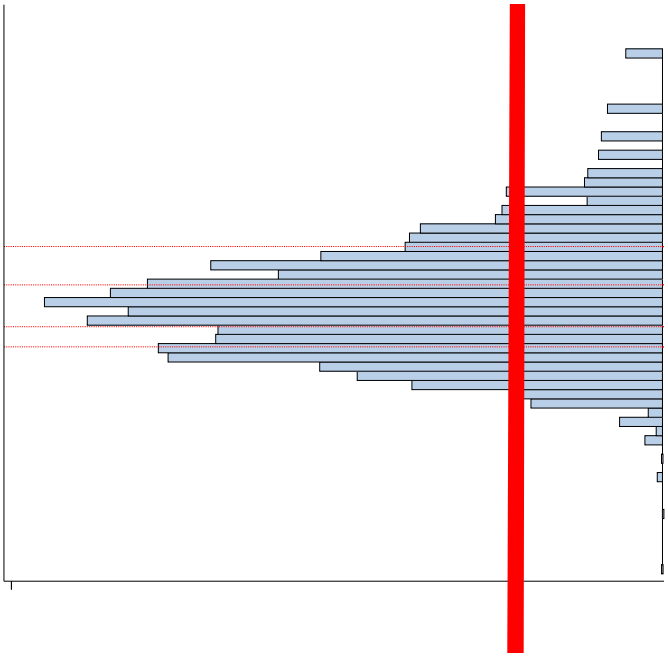
)LJXUH 6WXGHQW 3HUIRUPDQFH 0DS 5HJHQW,V ([DPLQDWLRQ LQ $OJHE



1<5HJHQWV $OJHEUDLF, 35HSRUWHG IRU 1<6(' E\ 3HDUVRQ

8QLGLPHQVLRQDOLW\

5DVFK PRGHOV DVVXPH WKDW RQH GRPLQDQW YDULDWLRQ GLPHQVLRQ
SHUIRUPV3QFLHQWRPSRQHQWDQDO\VLV 3&$ FDQ EH XVHG WR DVVHVV W
DVVXPSWLRQ 7KH SXUSRVHIXOZKHWKHUDQGKRZWKHQHZ GLPHQVLRQV FRPS
H[LVW DPRQJ ,WKDLWRWKU GLPHQVLRQV DUH IRXQG WRXOGQLGLP
EH YLRODWHG

$ SDUDOOHO DQDO\VLV +RUQ ZDV FRQGXFWHG WR KHOS GL
FRPSRQHQWVDWH3DUDOOHO DQDO\VLVLWHUDWHRHDWWKRZQHDIWRUV
H[LVW LQ SRUSRUWLRQV WKH SDUDOOHO DQDO\VLV VHTXDQGWRRVGHW
RULJLQDZHUGDWDDWHG)RU HDFK UDQGRPRDQGWKHDUHVXOWZD
HLJHQYDOXHVRUVWDFKHGRPSRQHQW WKH XSSHUGLWWUHLQRQL
HLJHQYDOXHV IURP WKH UDQGRPGDWD*LWWQ ZDVH VL]H RI WKH
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DQ HLJHQYDOXH RI

)LJXUHSUHVHQWVWKH3&$G SDUDOOHOHVXOWVRQWKH([DPLQDWLRQ LQ
,, 7KH UHVXOWV LQFOXGH WKH HLJHQYDOXHV DQG WKH SHUFHQW

7KH 5DVFK GLIILFXOW\ SDUDPHWHUV IRU WKH LWHPV RQ WKH ED
VFRWWRDVFK VWXGHQW DELOLW\ WKHWD VFRUH UHODWLRQVKLS
WKH 5DVFK WKHWD VFRUH DQG WKH VFDOH VFRUH WR EH NQR
UHODWLRQVKLS ZLWK WKH FHUWDLQW\ RI RXWFRPHV HYDFKHWWHQW IURP WKH
RI LWHPV DVVXPHG WR OLH SUHYLRXVLOHGHDWKZRLFK KDG NQRZQ 5DVFK
GLIILFXOW\ SDUDPHWHUV 7KHVH NQRZQ SDUDPHWHUV ZHUH W
EHWZHHQ WKH UDZ DQG 5DVFK WKHWD VHDWWHUHDXWKHQWLFK GLIILFXO
SDUDPHWHUV DUH DOO RQ D FRPPRQ VFDOH WKH 5DVFK WKHWD
ZLWK SUHYLRXVO\ DGDSWHG LWHP SDUDPHWHUV LQ WKH VFDOLQJ SU
VFDOH VFRUHIRUPXODWKH 5DVFK WKHWD VFRUH FRUUHVSRQGLQJ WR
QHZ IRUP XVLQJ WKH VFDOH WKHWD VFRUH UHODWLRQVKLS HVWDEOLVKHG LQ
YLD OLQHDU LQWHUSRODWLRQ

7KLV SURFHVV UHVXOWV LQ D UHODWLRQVKLS EHWZHHQ WKH
VFRUHV 7KH VFDOH VFRUHV FRUUHVSRQGLQJ WR HDFK UDZ VFRU
IRU UHSRUWLQJ RQ WKH FRQYHUVLRQ FKDUW SRVWHG DW WKH
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&KDSWHU 5HOLDELOLW\ 6WDQGDUG

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$FFRUGLQJ WR VWDQGDUGV IRU (GXFDWLRQDO 3V\FKRORJLFDO 7HVWV DQG KDQGERRNV RI WHVW GHYHORSPHQW DQG SUDFWLFH DOO WHVWV VKRXOG EH UHOLDEOH WR DQ DSSURSULDWH GHJUHH 7KH PLQLPXP DFFHSWDEOH OHYHO RI UHOLDELOLW\ GHSHQGV RQ WKH XVH WR ZKLFK D WHVW LV WR EH SXW DQG WKH YDULDELOLW\ RI WKH JURXS RQ WKH DWWULEXWH EHLQJ PHDVXUHG 7KXV D WHVW RI DSWLWXGH RU DFKLHYHPHQW PD\ EH VXIILFLHQWO\ UHOLDEOH IRU JURXS FRPSDULVRQV EXW QRW IRU GHFLVLRQV DERXW LQGLYLGXDOV 7KH UHOLDELOLW\ RI D WHVW LV FRQFHUQHG ZLWK WKH FRQVLVWHQF\ RI VFRUHV REWDLQHG E\ WKH VDPH LQGLYLGXDOV RQ GLIIHUHQW RFFDVLRQV RU ZLWK GLIIHUHQW VHWV RI HTXLYDOHQW LWHPV 7KH UHOLDELOLW\ RI D WHVW LV DVVHVVHG E\ YDULRXV SURFHGXUHV GHVFULEHG LQ WKLV FKDSWHU

7KLV FKDSWHU GLVFXVVHV UHOLDELOLW\ IURP WKUHH EURDG SRLQWV RI YLHZ ,W GHVFULEHV WKH PXOWLSOH GGGLWLRQDO VWDWLVWLFDO PHDVXUHV WR GGGUHVV WKH PXOWLSOH H[DP¶V UHOLDELOLWLHV GLVFXVVHV WKH UHODWLRQVKLS EHWZHHQ UHOLDELOLW\ DQG WKH VWDQGDUG HUURU RI PHDQV

5(/,$%,/,7< ,1',&(6 67$1'$5'

&ODVVLFDO WHVW WKHRU\ GHVFULEHV WKUHH GLIIHUHQW EXW UHODWHG DSSURDFKHV WR UHOLDELOLW\ 7KH UHOLDELOLW\ FRHIILFLHQW LV GHILQHG DV WKH SURSRUWLRQ RI WUXH VFRUH YDULDQFH LQ D VHW RI VFRUHV SUHVHQW WKH YDULDQFH LQ WKH REVHUYHG VFRUHV GXH WR WKH LPSHUIHFWL SURFHVV, RU RWKHU WKH YDUL@¼, p 33”! WRPI

5HOLDELOLW\ LV PRVW RIWHQ HVWLPDWHG XVLQJ FKLSHUV GHVLJQHG
SUDFWLFDOO\ QHYHUQDWHG RQ VLPLODU [LDOSHQ EDVH FRQFHSWXDOL]HG DV W
ZKLFK DQ H[FKDQJHDEOH VHW RI LWHPV IURP WKH VDPH GRPDLQ
RI VWXGHQWV

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)LJXUHV KRZ WKLV W&\SLFDO YDULDWLRQ LQ 5HJHQWV ([DPL,QDWLRQ LQ $
WKH FRPSUHVVLFRQ WKRFDUGHZ VFRUHV DURXQG FKDQJH WKH VKDSH RI
WKH FXUYH 7KLV LV HVSHFLDOO\ HORI H[DQVLRQ DQG FRQWUDFWLRQ DURXQG
DW WKH FKDQJLQJ GHQVLW\ RI UDZ VFRUH SRLQWV DORQJ WKH
7KH ODUJHVW FRPSUHVVLRQ FDQ EHWR HQVEDOWZHHQ

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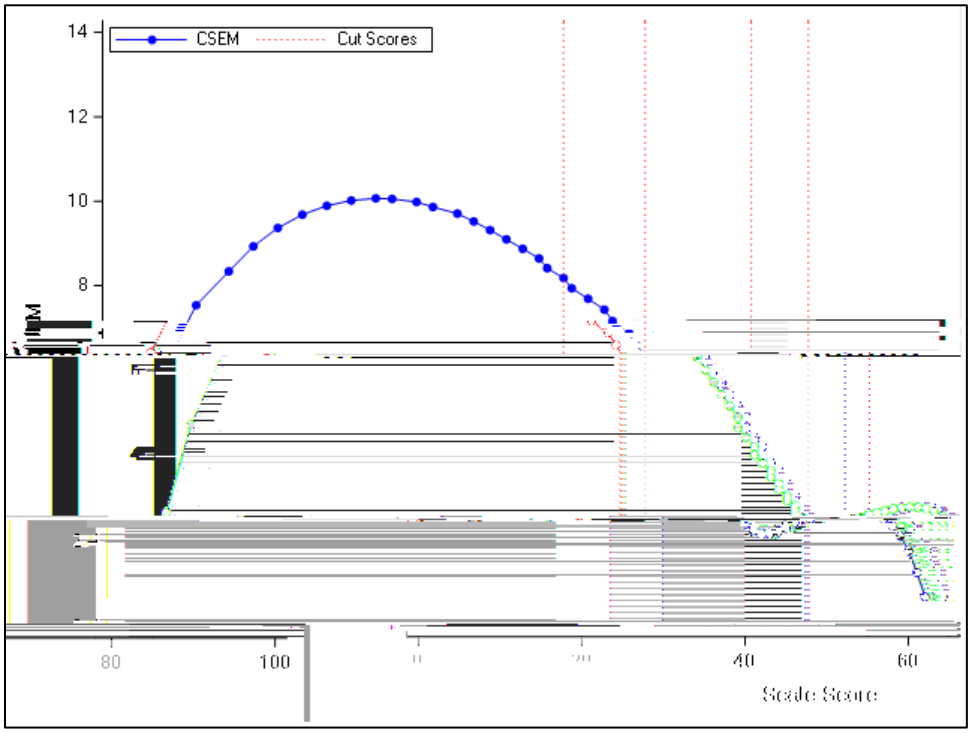

'(&,6,21 &216,67(1&< $1' $&&85$&< 67$1'$5'

,Q D VWDEOGVDUGG WHVWLQJ SURJUDP WHVW LQ NQRZLQJ KRZ D
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WKH UHODWLYH QXPEHU RI VWXGHQWV LW LV WKH DEVROXWH
LQ GHFLVLRQ FRQVLVWHQF\ DQG DFFXUDF\

&ODVVLILFDWLRQ FRQVLVWHQF\ UHIHUV WR WKH GHJUHH WR
FDQ EH UHSOLFDWHG XSRQ UHWHVWLQJ XVLQJ DQ HTXLYDOHQW
DQVZHUV XVHG WR GHWHUPLQH LV WKH LQLWLDO WHVW" ,I WZR SDUDOOHO IRUP
WKH FRQVLVWHQF\ RI WKH PHDVXUH ZRXOG EH
GHFLVLRQV PDWFKHG WKH GHF
WHVW VFRUHV

&RQVLVWHQF\ DQG DFFXUDF\ DUH LPSRUWDQW FRQFHSWV DV EHKLQG LQ
7HVW SURFHGXUH KRZ SUREDEOH ZRXOG LW EH WKDW WKH VWXGHQW ZL
FDWHJRULHV WKDW WKH VWXGHQW HDUQHG RQ WKH RWKHU HTXDOO\ GLIILFXOW

1<5HJHQWV $GYDQFHG &RQFHSWV 3UHSDUDWRU\ IRU 1<6(' E\ 3HDUVRQ

M M M

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7KH VXP RI WKH GLDJRQDO HOHPHQWV RI D VTXDUH PDWUL[LV FDOOHG WKH WUDFH RI WKH PDWUL[DQG LV GHQRWHG E\ WU

7DEOH 3VHXGRFLVLRQ 7DEOH IRU 7ZR +\SRWKHWLFDO &DWHJRULHV

	7HVW	
	/HYHO	/HYHO 0DUJLQ

7HVW\

OHVVRQV DUH DOVR DYDLODEOH
ZLWK WKH SURJUDP

7KH LWHP VKRXOG EH ZULWWHQ WR UHTXLUH D VSHFLILF IRUP
3KUDVH OLNH ´WKH QHDUHVW WRZQ´ RU ´WKH ODVW WLPH \RX VDZ
WKH ZULWLQJ RI WKH UXEULF IRU WKHVH W\SHV RI LWHPV

,WHPV WKDW UHTXLUH VWXGHQWV WR H[SODLQ LQ ZRUGV DUH
2QH RI WKH HPSKDVHV RI WKH UXEULF LV WKDW VWXGHQWV
FRPSUHQVLFDWH PDWKHPDWLFDO WKLQNLQJ $Q H[DPSOH LV WR
DUJXPHQWV VXFK DV WR PDNH FRQMHFWXUHV DQDO\]H wv€0y)À