$Q ([SORUDWLRQ RI)HDVLEOH $SSURDFKH
0XVLF 7KHUDS\

<XWLQJ :X[D]

8QLYHUVLW\ RI (GLQEXUJK &RPPXQLFDWLRQ DQG 6RFLDO 6FLHQFHV (GLQEXUJK 8.

$EVWUDFW 6WUHVVIXO DQG HYHQWIXO DQG VWUHVVIXO ZRUNLQJ HQYLURQPHQWV DUH FRPPRQ LQ PRGHUQ FXOWXUH
VLJQLILFDQWO\ DIIHFWLQJ PHQWDO ZHOO EHLQJ DQG SURGXFWLYLW\ 7KH SXUSRVH RI WKL
LQYHVWLJDWH WKH SRWHQWLDO RI VRXQGVFDSH LQWHUYHQWLRQV WR VXSSRUW ZRUNHUV LQ WKH ZRUNSODFH
VRXQGVFDSH GHYHORSPHQW ZLWK PXVLF WKHUDS\ DSSURDFKHV DV PHUJLQJ
HIIHFWV RI VRXQGVFDSH ZLWK PXVLF WKHUDS\ RQ PHQWDO KHDOWK DQG ZRUN HQYLURQPHQW
:H ZLOO DOVR ORRN DW FXUUHQW DSSOLFDWLRQV RI VRXQGVFDSH DQG KRZ WKHVH
LQFRUSRUDWHG DQG H[DPLQHG HDUO\ LQ WKH SURFHVV RI GHVLJQLQJ
YDOLGDWH WKH IHDVLELOLW\ RI VRXQGVFDSH PXVLF WKHUDS\ LQ WKH ZRUNVSDFH
WKH KRSH RI LPSURYLQJ ZRUNLQJ VSDFH ZLWK PXVLF WKHUDS\
WKHUHE\ LPSURYLQJ WKH RYHUDOO ZHOO EHLQJ RI HPSOR\HHV
FRSH ZLWK VWUHVV LQ WKHLU ZRUN DQG OLIH

,QWURGXFWLRQ

6RXQGVFDSHV DUH LQWULJXLQJ VRXQG VHWWLQJV WKDW FDQ JHQHUDWH D VHUHQH UHOD[LQJ RU PRWLYDWLQJ HPRWLRQDO H[SHULHQFH DQG KDYH D SRZHUIXO SRVLWLYH HIIHFW RQ PRRG 0XVLF WKHUDS\ LV D SV\FKRWKHUDS\ PHWKRG WKDW XVHV FHUWDLQ VRXQGV WR GLUHFWO\ DIIHFW WKH KXPDQ SV\FKH DQG FDXVH XVHIXO LQWHUYHQWLRQV ,W KDV EHHQ ZLGHO\ XWLOL]HG IRU HPRWLRQDO PDQDJHPHQW DQG UHFRYHU\ 6RXQG HQYLURQPHQW KDV EHHQ H[WHQVLYHO\ UHVHDUFKHG GXULQJ WKH ODVW WZR GHFDGHV DQG VRXQGVFDSH KDV HPHUJHG DV D PDMRU DFDGHPLF DUHD 7KH FRQFHSW RI VRXQGVFDSH ZDV ILUVW SUHVHQWHG LQ WKH ODWH V ZLWK UHJDUG WR DFRXVWLF HFRORJ\ DQG LW KDV VLQFH EHHQ VXEVFULEHG E\ VFKRODUV VWXG\LQJ YDULRXV W\SHV RI VRXQGVFDSHV 6FKDIHU FODLPHG WKDW DOO XUEDQ VRXQGV VKRXOG EH VWXGLHG WUHDWLQJ WKH DFRXVWLF HQYLURQPHQW DV D ILHOG RI VWXG\ DQG GHILQLQJ WKH VRXQGVFDSH DV D UHVRXUFH> @ D GHILQLWLRQ E\ ZKLFK UHVHDUFKHUV KDYH H[WHQGHG WKH VWXG\ RI WKH VRXQGVFDSH WR D EURDGHU UDQJH RI GLVFLSOLQHV DQG DSSOLFDWLRQV LQ IRU KXPDQ KHDOWK DQG SXEOLF VDQLWDWLRQ UDWKHU WKDQ VLPSO\ YLHZLQJ LW DV D VHSDUDWH VRXUFH RI QRLVH> @ 6RXQGVFDSH KDV VKLIWHG IURP DQ HPSKDVLV RQ HQYLURQPHQWDO QRLVH WR SK\VLFDO FKDUDFWHULVWLFV RI WKH DFRXVWLF HQYLURQPHQW WR D IRFXV RQ KXPDQ SHUFHSWLRQ DQG FKDUDFWHULVWLFV EDVHG RQ WKH DFRXVWLF HQYLURQPHQW DV SHUFHLYHG RU H[SHULHQFHG DQG RU XQGHUVWRRG E\ D SHUVRQ RU SHRSOH LQ FRQWH[W DV SURSRVHG E\ WKH LQWHUQDWLRQDO VWDQGDUG ,62 > @ $V D UHVXOW VRXQGVFDSH UHV[...] XQGHUVWDQGLQJ WKH OLQN EHWZHHQ KXPDQV DQG WKH DFRXVWLF

HQYLURQPHQW DV ZHOO DV LQYHVW[...] UHDFW WR FKDQJHV LQ VRXQG HQYLURQPHQW

&XUUHQW 5HVHDUFK DQG 'HY[...] 6WDWXV

3UHYLRXV UHVHDUFK KDV IRXQG WKDW [...] LPSDFW RQ SHRSOH V PRRG DQG KHDOWK [...] VWUHVV UHGXFWLRQ IRU WKH ZRUNLQJ [...] VWXG\ KDV D UHYLHZ 6RXQG RI VWXGLHV [...] QHJDWLYH LPSDFWV RI DPELHQW VRXQG [...] EDVHG RQ VRXQGVFDSH KDV HPHUJHG DV D UHVHDUFK [...] VXUYH\ HG ZKDW SRVLWLYH HYDOXDWLRQ [...] UHFRYHU\ DQG TXDOLW\ RI OLIH ZK[...] EHWWHU VHOI UHSRUWHG KHDOWK> @ [...] QDWXUH VRXQGV DUH IUHTXHQWO\ DV[...]

D #TT FRP

06, > @ DV ZHOO DV WKH XVHI
ORZHULQJ VWUHVV LQ KXPDQV
SDWLHQWV
:H FDQ LQIHU IURP WKH VWXG
FXUUHQWO\ QRLVH
WKH TXDOLW\ RI WKH VRXQGVFD
QRLVH SHUFHLYHG E\ WKH OLVWH
WKHUDS\ WR FRQWH[WXDOL]H V
DUUDQJLQJ WKHP> @ :H SURSR
SV\FKRWKHUDS\ DSSURDFKHV ZL
VRXQGVFDSHV WR FUHDWH D Q
DOOHYLDWHV VWUHVV LQ WKH Z
VRXQGVFDSH RI
ZRUNLQJ FRQGLWLRQV DQG HQKD

7KH &RQQHFWLRQ EHWZHHQ 6RXQGVFDSH DQG (PRWLRQV

7KH GHILQLWLRQ RI VRXQGVFDS
VRXQGV LQ WKH UHJLRQ HQFRPS
ZLQG ELUGVRQJ ZDWHU IORZ
KXPDQ YRLFHV PDFKLQH VRXQG
VWXGLHV FRQVFLRXV DQG VXEF
PD\ LQIOXHQFH WKH SHUFHSWLR
FRQVWUXFWLQJ DQG SUHGLFWLQ
LQ SRVLWLYH UDWLQJV> @ +RZH
DFWLYHO\ FRQV
LQGXFH DQG VWHHU KXPDQ HPR
SUDFWLFH RI DXGLWRU\ HQYLUR
HPRWLRQV LV D IXQGDPHQWDO F
KHQFH LW LV FULWLFDO WR H[
VRXQGVFDSH VWXG\> @ 1XPHUR
FRQGXFWHG RQ WKH UHODWLRQ
KXPDQ EUDLQ DQG SV\FKRORJ\
LPSDFW RQ KXPDQ HPRWLRQV LQ
LQWHQWLRQDOO\ JHQHUDWHG
HQYLURQPHQW KDV D PRUH VXEW
LPSDFW RQ HPRWLRQV $ VXEVW
H[LVWV WKDW GHVFULEHV WKH Q
SRZHU WR HOLFLW HPRWLRQ
QHXUDO PHFKDQLVPV FDSDEOH
HPSKDVL]LQJ WKH
SUHIURQWDO FRUWH[DP\JGDOD
HPRWLRQDO SURFHVVLQJ DQG
UHGXFH VWUHVV RU DOOHYLDWH
DQRWKHU H[DPSOH WKH HPRWLR
KDSSLQHVV RU VDGQHVV DUH Z
ZLWK VWXGLHV VKRZLQJ WKDW
ZLWK WKH SURFHVVLQJ RI DYHU
SDUDKLSSRFDPSDO
UHVSRQVHV WR GLVVRQDQFH> @
DVVRFLDWHG Z
DURXVDO OHYHOV VXUSULVH
GRSDPLQH UHODWHG VWUXFWXUH
GXULQJ HQMR\DEOH OLVWHQLQJ
EH SOHDVXUDE
.RHOVFK GHVFULEHG FKDQJHV
UHVSRQVH WR PXVLF LQ D VLPL
WKDW PXVLF FDQ HOLFLW D ZLGH
SOHDVXUH VDGQHVV H[FLWHPHQW DQG VR RQ DQG WKDW WKHVH
DUH UHDOL]HG QRW RQO\ WKURXJK WKH YDULRXV HOHPHQWV RI

Sound spectrum research method

Sound spectrum basic concepts

Sound spectrum measurement

Sound spectrum analysis

Sound spectrum application in music education

Sound spectrum and music perception

Sound spectrum and music creation

Sound spectrum and music performance

Conclusion

WRQHV> @ DV ZHOO DV IXUWKHU UH
VRXQG HYRNHG HPRWLRQDO H[SH

([SHULPHQWDO GHVLJQ IRU 6RXQGVFDSH LQWHJUDWHG 0XVLF WKHUDS\

7KH *XLGHG ,PDJHU\ DQG ,PDJLQDWLRQ *0
SUDFWLFHG WKURXJK PXVLF LV
PXVLF WKHUDS\ DSSURDFKHV WR
VXJJHVWV WKDW WKH XVH RI WK
:HVWHUQ WRQDO PXVLF LQ WKH
DSSURDFK WR HQKDQFH WKH ED
DQ LPSRUWDQW UDWLRQDOH IRU
LQWHJUDWLRQ RI PXVLF WKHUDS\ DQG VRXQGVFDSH
DSSURDFKHV> @
7KLV PHWKRG KDV EHHQ XVHG LQ
VRXQGVFDSH IDFWRUV WR WU\ WR
EHWZHHQ PXVLFDO VWUXFWXUH
PXVLF SURGXFHG E\ VSHFLILF
EDVHG RQ ERG\ VFKHPD WR XQ
SURGXFHG ZKHQ OLVWHQLQJ WR
VHQVDWLRQV RI WKH KXPDQ H[SH
GHPRQVWUDWLQJ WKDW VRPH RI
EH H[SODLQHG LQ ZRUGV DQG LPD
LQYROYHG> @ DQG EDVHG RQ
WUDQVGXFWLRQ DQDO\]H DQG G
VSHFLILF ZD\ :H GHVLJQHG D
UHVHDUFK RQ WKH FRPELQDWLRQ
WKHUDS\ EDVHG RQ WKLV PXVLF
SURYHQ IHDVLELOLW\ RI FRPEL
DVVHVVLQJ DQG FDWHJRUL]LQJ
VRXQGVFDSHV WKURXJK TXHVWL
PXVLF WKHUDSLVWV WR VHW XS
IHZ LQWHUYHQWLRQV EDVHG RQ
SURYLGLQJ VSHFLILF LQWHUYHQ
LQWHUYHQWLRQV DQG DQDO\VHV
LQ VWUHVV PHDVXUHPHQWV
SHULRG ZLWK WKH VSHFLILF SUR

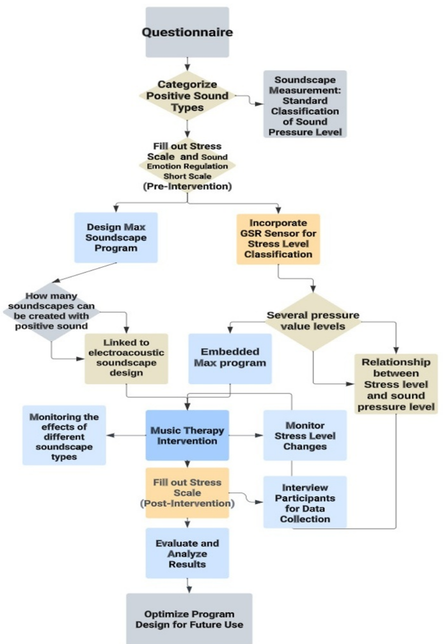

Fig. 1. 3URMHFW 'HVLJQ)ORZ FKDUW

$V TXHVWLRQQDLUH VXUYH\ FRQGXFWHG
DQDO\]HG> @ GHWHUPLQH WKH WDUJ
RI \HDUV ROG ZKLOH DFWXDO \
PHDVXUHPHQWV ZHUH WDNHQ RQ WK
ZRUN VFHQH VSDFH DQG WKH VRXQ
VHHW WKH VSHFLILF HQYLURQPHQW
VRXQGVFDSH HQYLURQPHQW DVVHVV
KDQG WKH VRXQGVFDSH ZLOO LQFOX
DQG ZH ZLOO UHFRUG WKH PRUH HIIHFWLYH
DQG EHDFK WR FUHDWH WKH FRUH V
PXVW EH GHVLJQHG E\ LQWHJUDWLQJ
*XLGHG ,PDJHU\ DQG 0XVLF
WKH VRXQGVFDSH ZLWK HOHFWURDF
FUHDWH D QHHGHG HOHFWURDFRXVWLF HHFWV
PXOWLSOH VSHDNHUV VWXG\ RI WKH
HQYLURQPHQWDO UHTXLUHPHQWV
7KH W\SH RI VRXQGVFDSH DQG
WHFKQRORJ\ GHWHUPLQHG 7KH
XVLQJ DXGLR HTXLSPHQW RU WZHQW
DQG WKH PHQWDO LPDJHV 0D[P
WKHUDSLVW XVLQJ WKH 0D[PVS
LPSURYLVDWLRQ> @ WRRO> @ LV 7KH PXVL
RI WKH VRXQGVFDSH VRXQG FRQWL
PXVLF OHYHO RI WKH VSDFH DQG WK
VWDWH RI WKH VSDFH DQG KDV
VSDWLRWHPSRUDO V SURPLQHQW IHDWXUH
JHVWXUHV DQG LGHDO HYSUHVVLRQ
GLVWXUEDQFH SURFHVV EHLQJ IR
DPELHQFH WKH YLVLWRUV WKH LQWHUYHQ
PL[WXUHV DW D WLPH WKUHH WLP
SURPRWH VRXQGVFDSHV DQG PXVLF
WKHUDS\ DSSURDFK DQG WKH

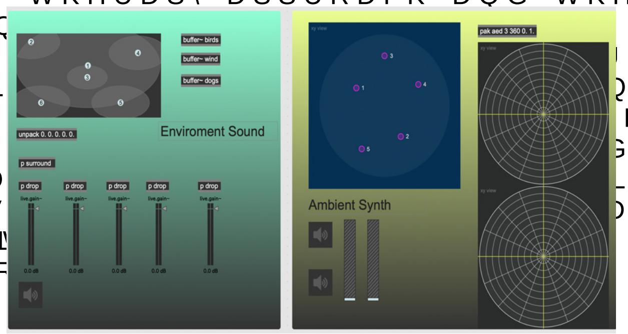

Fig. 2. 6XUURXQG 6RXQG (OHFWURDFRXVWLF 6\
6RXQGVFDSH &UHDWLRQ ,OOXVWUDWLRQ
VRXQGVFDSH XVLQJ FRQWUROOHU @RZLQJ
DPELHQW HIIHFWV XVLQJ >DPELHQFRGH
REMHFW DV ZHOO DV VRXQG V\QW

7KH LPSDFW RI WKH PXVLFDO
LQWHUYHQWLRQ RQ WKH HQYLURQP
HPRWLRQDO VWDWH RI WKH LQGLYLG
WKLUG VWHS RI WKH LQWHUYHQWL
FROOHFWLRQ PHWKRGV DQG SK\V
PHDVXULQJ WKH JDOYDQLF VNLQ UH
LQFOXGHV REVHUYDWLRQ IHHGEDFN
ODWWHU HPSOR\V VHQVRUV DQG RWK
WKH SRSXODWLRQ V JDOYDQLF VNLQ
REWDLQ VWUHVV LQGLFHV IRU DFWXD
LQWHUYHQWLRQ SURFHVV LV DV IROO
$W ILUVW DQ $UGXLQR DQG *URYH
WR FUHDWH D VHQVRU GHYLFH WKDW
FURZG LQ D QRUPDO VWDWH QR VWU
EDVHOLQH DQG WKHQ PRQLWRU WKH

https://doi.org/10.1051/shsconf/202418303022

LQ WKH ZRUNLQJ HQYLURQPHQW
VWDWHV RI OLJKW PHGLXP KHDY
YDOXH WR EH SDVVHG LQWR WKH
IHHGEDFN LPPHGLDWHO\ DIWHU
DUUDQJHV DQG FRPELQHV WKH
WKH YDOXHV DQG
DQG FRPELQHV
LQGLFHV DQG WKH SUH TXHVWL
HIIHFWLYH IRU VWUHVV UHOLHI
FRPELQDWLRQ
GLIIHUHQW HQYLURQPHQWDO
HPSOR\V D VXUURXQG
RSHUDWLRQ DQG H[HFXWLRQ RI P
WKH VDPH WLPH ZKLOH DOVR S
EDVHG RQ WKH HOHFWUR DFRXVWL
HQYLURQPHQWDO VRXQG WR FUH
WHVWLQJ WKH FKDQJH RI WKH SU
FRQVFLRXVO\ FRQWUROOHG HQY
LQWHQGHG WR EH FDUULHG RXW I
DGMXVWPHQWV DQG VRXQG DUU
WKH JRDO RI GH
FDQ KDYH D SUR
RI WKH ZRUNLQJ SRSXODWLRQ
WKH HIIHFWV RI WKH JLYHQ VSDF
FKDQJHV LQ WKH
WKH YDOXHV RI WKH VWUHVV GDWD HPDQDWLQJ IURP WKH 0D[
SURJUDP GXULQJ WKLV SURFHVV DQG GHULYHG D EDVLF
HYDOXDWLRQ GDWD IURP WR GRFXPHQW WKH LPSDFWV RI WKH
LQWHUYHQWLRQ

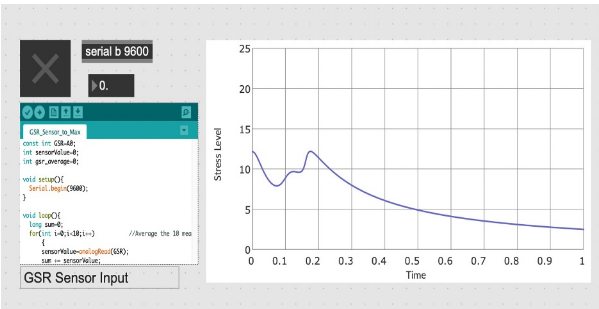

Fig. 3. *UDSKLFDO UHSUHVHQWDWLRQ RI WKH PHDVXUHG SUHVVXUH ... WKH *65 6HQVRU ... WKH 0D[SURJUDP WR YLVXDOL]H ... REMHFW

7KH HIIHFWV RI WKH LQWHUYHQWLRQ ZHUH TXDQWLILHG DIWHU WKH LQWHUYHQWLRQ XVLQJ D VWUHVV VFDOH DQG VXUYH\ VXFK DV WKH 3HUFHLYHG 6WUHVV 6FDOH 366 ... FRPSOHWHG WKH VFDOH WZLFH EHIRUH DQG DIWHU WKH LQWHUYHQWLRQ WR DVVHVV FKDQJHV LQ WKHLU VWUHVV OHYHOV DQG WKH HIIHFWV RI VRXQGVFDSH VWUHVV UHOLHI XQGHU PXVLF WKHUDS\ ZHUH DOVR DQDO\]HG EDVHG RQ D FRPELQDWLRQ RI SK\VLRORJLFDO GDWD PHDVXUHPHQWV EHIRUH DQG DIWHU WKH LQWHUYHQWLRQ DV ZHOO DV WKH UHVXOWV RI WKH DIIHFWLQJ PRRG VFDOH TXHVWLRQQDLUH ... TXDQWLWDWLYH GDWD WKH ZRUNLQJ SRSXODWLRQ V ... DQG IHHGEDFN RQ WKH VRXQGVFDSH ... JDWKHUHG WR ...

7R GHWHUPLQH WKH HIIHFWLYHQHVV RI PXVLF WKHUDS\ ZLWK WKH ZRUNLQJ SRSXODWLRQ SV\FKRORJLFDO GDWD ZDV HYDOXDWHG 7KH SV\FKRORJLFDO DQG

&RQFOXVLRQ

7KLV DUWLFOH VWXGLHG WKH LGHD ... DQG PXVLF WKHUDS\ ... LQWHQWLRQ WKDW LW FDQ EH XVHG ... PHDVXUHPHQW DQG SUDFWLFH LQ WK ... UHVHDUFKLQJ VRXQGVFDSH DQG PXV ... WKHUH DUH PDQ\ VRXQGVFDSH UHYL ... VWLOO PDQ\ SRVVLEOH FLUFXPVWDQ ... WKH HQYLURQPHQW DQG LQ OLIH 7K ... FDQ EH FRPELQHG ZLWK DUWLILFLD ... DIWHU WKH RSHUDWLRQ ... LQWHUYHQWLRQ ... RI GDWD FDQ EH FDUULHG RXW WKUR ... FRVWV ... LQWHOOLJHQFH WR DFKLHYH WKH LQ ... HIIHFW ... VFHQDULRV ...

5HIHUHQFHV

$XWKRUV VKRXOG XVH WKH IRUPV ... WKH ILQDO ...
6RXQGVFDSH ... *Soundscape J. Acoust. Ecol.* ±
... DQG ... 3OHWWD ...) ... *HVWDOQG ...
%RWWHOGRRUHQ ... %RVFK ... 'HYHOR ... DQ DPS ... *HQLXV ...)LHELJ $ ...
... 0DIILHL ... /DYLD ... 7K ...
RQ WKH VRXQGVFDSHV RI WKH ... *Building and Environment* *108* ±

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Journal of Urban Design 10
Music Perception 30
People and Nature 3
PLoS ONE 8
HERD: Health Environments Research & Design Journal 10

,UZLQ $ +DOO ' $ 3HWHUV $ 3ODFN & - /LVWHQLQJ WR XUEDQ VRXQGVFDSHV 3K\VLRORJLFDO YDOLGLW\ RI SHUFHSWXDO GLPHQVLRQV *Psychophysiology 48* ±

.DZDKDUD < <RVKLGD + 3RWWLHU / 0DUHW 3 *Detection of Factors Affecting Cognitive Function in Environmental Sounds*

:DOOPDUN = ,DFRERQL 0 'HEOLHFN & .HQGDOO 5 $ (PERGLHG /LVWHQLQJ DQG 7LPEUH *Music Perception 35* ±

.RHOVFK 6 0XVLF(HYRNHG HPRWLRQV 3ULQFLSOHV EUDLQ FRUUHODWHV DQG LPSOLFDWLRQV IRU WKHUDS\ *Annals of the New York Academy of Sciences 1337* ±

$NVQHV + 5XXG (%RG\ EDVHG VFKHPDWD LQ UHFHSWLYH PXVLF WKHUDS\ *Musicae Scientiae 12* ±

$NVQHV + 5XXG (0HWRQ\PLF $VVRFLDWLRQV RI 1DWXUH DQG &XOWXUH LQ D %0*,0 3URJUDP *Nordic Journal of Music Therapy 15* ±

7UXD[% 6RXQGVFDSH &RPSRVLWLRQ DV *OREDO 0XVLF (OHFWURDFRXVWLF PXVLF DV VRXQGVFDSH *Organised Sound 13* ±

6DQGDN % &RKHQ 6 *LOERD $ +DUHO ' &RPSXWDWLRQDO HOXFLGDWLRQ RI WKH HIIHFWV LQGXFHG E\ PXVLF *PLOS ONE 14* H

-DLPRYLFK - &RJKODQ 1 .QDSS 5 % &RQWDJLRQ RI 3K\VLRORJLFDO &RUUHODWHV RI (PRWLRQ EHWZHHQ 3HUIRUPHU DQG $XGLHQFH $Q ([SORUDWRU\ 6WXG\ *Bio-inspired Human-Machine Interfaces and Healthcare Applications,* .

/X : %LDQ 4 :DQJ : :X ; :DQJ = =KDR 0 &KLQHVH YHUVLRQ RI WKH 3HUFHLYHG 6WUHVV 6FDOH $ SV\FKRPHWULF VWXG\ LQ &KLQHVH XQLYHUVLW\ *PLOS ONE 12* JUDGXDWH VWXGHQWV H

$EGDOUDKPDQ = *DOEUXQ / 6RXQGVFDSH DVVHVVPHQW RI D ZDWHU IHDWXUH XVHG LQ DQ RSHQ SODQ RIILFH *Proceedings of 33rd PLEA International Conference: Design to thrive.* YRO