UO‘K 519.248:[33÷301]

PEDAGOGIK TAJRIBA MA’LUMOTLARINI STATISTIK TAHLIL QILISHDA NAZORAT KARTALARIDAN FOYDALANISH ALGORITMI HAQIDA

X.D.Yuldashev

Pedagogik tajriba ma’lumotlarini tahlil qilishda statistik kriteriydan foydalanishning umumiy algoritmi ma’lum. Algoritmda asosiy gipoteza shuki, nazorat qilinuvchi karta miqdorining qiymati kartaning yuqori chegarasidan baland bo‘lsa, nazorat karta qabul qilinadi. Maqolada pedagogik tajribaning rejasi va tajriba ma’lumotlarini sxematik tahlil qilishda qanday nazorat kartadan foydalanish mumkinligi bo‘yicha tavsiyalar berilgan.

Kalit so‘zlar: *pedagogik tajriba, statistik instrumentlar, nazorat va tajriba guruhlari, statistik gipotezalar, nazorat karta, nazorat qilinuvchi miqdor, nazorat karta chegaralari, nazorat kartalarni ishlatish tavsiyalari.*

Известен общий алгоритм использования статистических критериев при анализе данных педагогического эксперимента. В алгоритме основная гипотеза такова, что контрольная карта принимается в случае, если значение величины контролируемой карты выше верхней границы данной карты. В статье даны рекомендации относительно того, какой контрольной картой можно пользоваться при схематическом анализе плана педагогического эксперимента и экспериментальных данных.

Ключевые слова. *Педагогический эксперимент, статистические инструменты, контрольная и экспериментальная группа, статистические гипотезы, контрольная карта, контролируемая величина, границы контрольных карт, рекомендации применения контрольных карт.*

Pedagogik jarayonlarda sodir bo‘ladigan hodisalarning qonuniyatlarini aniqlash bo‘yicha o‘tkazilgan tajriba ma’lumotlariga asosan statistik tahlil qilishda turli instrumentlardan foydalaniladi.

Bunda tajriba ma’lumotlari jarayonni xarakterlaydigan biror son-belgi (tasodifiy miqdor)ni tartib (rang) yoki nisbat shkalasida o‘lchash bilan to‘planadi. Bu son belgining turli xarakteristikalarini aniqlovchi statistik instrumentlar sifatida o‘rta qiymat, mediana, moda, tanlanma dispersiyalar, variatsiya qulochi, poligon, gistogramma va gipotezalarni tekshiruvchi statistik mezonlarni misol qilib ko‘rsatishimiz mumkin. Matematika fanining rivojlanishi bilan pedagogik jarayonlarni o‘rganishda ishlatiladigan bunday instrumentlar soni ko‘paymoqda.

Pedagogik tajriba yordamida izlanish gipotezasi empirik tasdiqlanadi yoki inkor etiladi. Shu bilan izlanuvchining nazariy natijasi (o‘qitishning yangi mazmuni, formasi, o‘qitish vositalari kabi) to‘g‘ri yoki noto‘g‘ri ekanligi statistik isbotlanadi va tajribada qatnashgan respondentlarga yangi metodika bo‘yicha o‘tkazilgan pedagogik ta’sirning an’anaviy metodikaga qaraganda effektivligi asoslanadi. Bunda tajriba rejasi asosida tashkil qilingan nazorat guruhi (NG) va tajriba guruhi (TG) respondentlarini bitta son-belgiga nisbatan taqqoslanadi. Agar X va Y mos ravishda NG va TGlarini xarakterlovchi son-belgilar, $F(x)$ va $G(x)$ ularning taqsimotlari, $M(X)$ va $M(Y)$ ularning matematik kutilmalari bo‘lsa, u holda α qiymatdorlik darajasida izlanish gipotezalari quyidagi ko‘rinishlarda bo‘lishi mumkin:

A) $H_0: M(X) = M(Y)$; $\quad H_1: M(X) < M(Y)$;
B) $H_0: F(x) = G(x)$; $\quad H_1: F(x) > G(x)$.

Hozirda mazkur muammolarni yechishning an’anaviy usullari mavjud [1, 2, 3, 4]. Ushbu tajribada masalalarni nazorat karta (NK) deb ataluvchi yangi statistik instrument yordamida yechish algoritmlarini keltiramiz. Bu metod pedagogik tajriba natijalarini an’anaviy usulga nisbatan mukammalroq tahlil eta oladi.

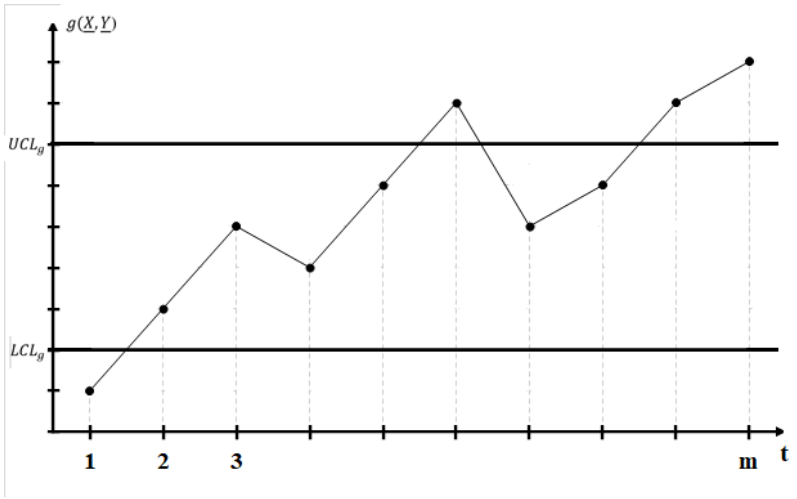
Turli xil tajriba natijalarini o‘lchashning to‘rt xil shkalasi mavjud: nominal, tartib (rang), interval va nisbat.

Pedagogik tajriba natijalari ko‘proq tartib yoki nisbat shkalalarida o‘lchanadi. Masalan, tajriba kriteriysi respondentning bilimi bo‘lib, uning xarakteristikasi (son-belgisi) qo‘yilgan ballar bo‘lsa, u tartib shkalasida

o'lchanadi. Agar kriteriy nazorat ishini bajarish bo'lib, uning son-belgisi bajarish vaqti bo'lsa, uni nisbat shkalasida o'lchaniladi [2]. Endi shu o'lchash ma'lumotlari va ularning sonli xarakteristikalariga asoslangan holda yangi statistik instrument NK tushunchasi va u yordamida statistik tahlil qilish usulini qisqacha bayon etamiz.

X dan $\underline{X} = (x_1, x_2, \dots, x_N)$ va Y dan $\underline{Y} = (y_1, y_2, \dots, y_M)$ o'lchash natijasida ma'lumotlar to'plangan va A hamda B guruh gipotezalarni tekshirishga moslashdan $g(\underline{X}, \underline{Y})$ statistika aniqlangan va tayin N va M, α qiymatdorlik darajasida $g(\underline{X}, \underline{Y})$ uchun $1-\alpha$ ishonchli ehtimol bilan ishonchli interval tuzilgan bo'lsin. Bu intervalning quyi chegarasini LCL_g va yuqori chegarasini UCL_g bilan belgilanadi. Dekart koordinatalar sistemasida gorizontal o'qda tanlanma olishning birlik $(t = 1,2, \dots, m)$ vaqtlarini va vertikal o'qda $g(\underline{X}, \underline{Y})$ ni qiymatlari hamda LCL_g, UCL_g nuqtalarni aniqlaymiz.

Tekislikda $(t;\ g(\underline{X}, \underline{Y}))$ nuqtalarni aniqlab, kesmalar bilan birlashtirgan holda siniq chiziq hosil qilinadi. LCL_g, UCL_g nuqtadan gorizontal o'qqa parallel $t = 1$ dan $t = m$ nuqtagacha to'g'ri chiziq kesmasini chizamiz. Natijada quyidagi ko'rinishdagi diagramma hosil bo'ladi.



1-rasm. g-NK.

Ushbu diagrammani g-NK deb nomlash mumkin. UCL_g – NKning yuqori nazorat chizig'i, LCL_g - NKning quyi nazorat chizig'i, $g(\underline{X}, \underline{Y})$ – nazorat qiluvchi miqdor deyiladi va ularni NK ning xarakteristikalari deyiladi. A va B masalalarga nisbatan 1-rasmdagi NK diagrammasi hosil bo'lsa, u holda quyidagicha xulosa qilinadi: agar $(t;\ g(\underline{X}, \underline{Y}))$ nuqtalar NK chegaralari orasida yotsa H_0 gipoteza α qiymatdorlik darajasida to'g'ri, aks holda $1-\alpha$ ehtimollik bilan H_1 gipoteza to'g'ri bo'ladi.

NK lar metodi bilan pedagogik jarayonlarni o'rganish bo'yicha bir necha tadqiqotlar amalga oshirilgan [5, 6, 7, 8]. Bizning ilmiy tadqiqotlarimiz ham ayni shu yo'nalishga asoslangan, tajriba natijalari e'lon qilingan maqolalarda avvalgi tajriba-sinov ishlarimizda A va B ko'rinishdagi masalalarni tahlil qilishga oid yangi NK lar qurish mumkinligi isbotlangan [9, 10]. Ushbu NKlar bilan turli A va B ko'rinishdagi masalalarni yechishda qo'llashga oid algoritmlar tuzish mazkur ishda rejalashtirilgan. Pedagogik tajribalarni tahlil qilishda A va B gipotezalarni tekshirishda $\alpha = 0{,}05$ olinadi. Shu sababli [9, 10] natijalarimizni unga moslab keltiriladi. Bu natijalari ma'lum bir kriteriylar asosida aniqlanganligi sababli topilgan NKning nomini ham shu kriteriyga mos simvol orqali belgilaymiz. Masalan, K kriteriyga mos nazorat karta K-NK tarzida nomlanadi.

1) [9] da Z-NK aniqlangan. Uning xarakteristikalari quyidagicha: $g(\underline{X}, \underline{Y}) = |\overline{X} - \overline{Y}|$ va $UCL_z = 1{,}65 \cdot \sqrt{\frac{D(X)}{N} + \frac{D(Y)}{M}}$, bu yerda $\overline{X}$ va $\overline{Y}$ tanlanma o'rta qiymatlar, $D(X)$ va $D(Y)$ – ma'lum dispersiyalar, $N > 30$, $M > 30$.

2) [9] da T-NK aniqlangan. Uning xarakteristikalari quyidagicha: $g(\underline{X}, \underline{Y}) = \frac{|\overline{X} - \overline{Y}|}{\sqrt{(N-1)S_X^2 + (M-1)S_Y^2}}$ va $UCL_T = t_{o'ng.\ kr.\ nuqta}(0{,}05; k) \cdot \sqrt{\frac{N+M}{N \cdot M \cdot (N+M-2)}}$, bu yerda X va Y normal taqsimlangan, $D(X) = D(Y)$ lekin noma'lum, $S_X^2 \approx D(X)$, $S_Y^2 \approx D(Y)$ – dispersiya baholari, $k = N + M - 2$ – Student taqsimotining ozodlik darajasi, $N < 30$, $M < 30$.

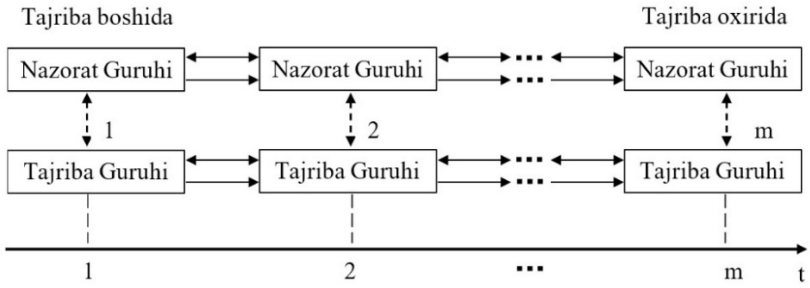
3) [11] da KW-NK aniqlangan. Uning xarakteristikalari quyidagicha: $g(\underline{X},\underline{Y}) = \frac{|\bar{X}-\bar{Y}|}{\sqrt{N\cdot S_X^2+M\cdot S_Y^2}}$ va $UCL_{KW} = \frac{1{,}65}{\sqrt{N\cdot M}}$, bu yerda S_X^2 va S_Y^2 X va Y larning dispersiyalari baholari.

4) [10] da λ-NK aniqlangan. Uning xarakteristikalari quyidagicha: $g(\underline{X},\underline{Y}) = \max\limits_x |F_N(x) - G_M(x)|$ va $UCL_\lambda = 1{,}34\cdot\sqrt{\frac{N\cdot M}{M+N}}$, bu yerda $F_N(x)$ va $G_M(x)$ uzluksiz X va Y son belgilarning empirik taqsimot funksiyalari, $N \geq 50$, $M \geq 50$.

5) [10] da χ^2-NK aniqlangan. Uning xarakteristikalari quyidagicha: $g(\underline{X},\underline{Y}) = \sum_{j=1}^{L} w_j v_{1j}$ va $UCL_{\chi^2} = N\omega + \chi^2_{0{,}95;\,L-1}\omega(1-\omega)$, bu yerda X va Y L ta ballarga mos qiymatlarni qabul qiluvchi son-belgilar ($L \geq 2$), $v_1 = (v_{11}, v_{12}, \dots, v_{1L})$ va $v_2 = (v_{21}, v_{22}, \dots, v_{2L})$, X va Y lar j ($j = \overline{1,L}$) ballarning chastotalari, $\omega_j = \frac{v_{1j}}{(v_{1j}+v_{2j})}$, $\omega = \frac{N}{N+M}$.

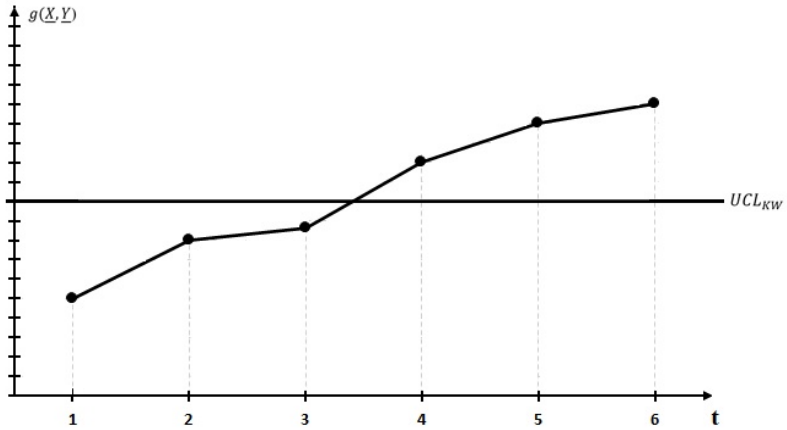
Endi Z, T, KW, λ va χ^2 – NK larning A va B muammolarni yechish algoritmini aniqlaymiz.

A va B guruh gipotezalarini tajriba davomida NK lar bilan tahlil qilish sxemasini taklif qilamiz.



2-rasm. NK bilan tajriba rejasi.

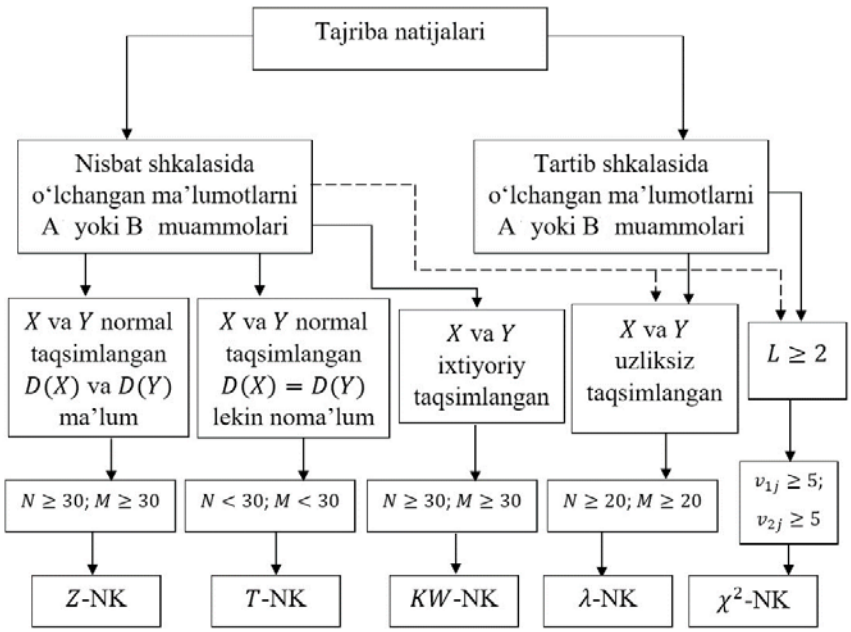
2-rasmdagi rejaga ko‘ra agar A) $H_0: M(X) = M(Y)$; $H_1: M(X) < M(Y)$ kabi bo‘lib, masalan, KW-NKsi bilan tekshirilgan bo‘lsa, u holda NK diagrammasi quyidagicha bo‘lishi mumkin.



3-rasm. KW-NK.

Bunda agar tajriba 1 yil davom etgan va har 2 oyda pedagogik ta’sir tekshirilib, NG va TG farqlari o‘rganilgan bo‘lsin. Diagrammadan 6 oy davomida H_0 gipoteza o‘rinli bo‘lgan, ya’ni NG va TG farqlari bo‘lmagan. So‘ngi 6 oy davomida asosiy H_1 gipoteza o‘rinli, ya’ni pedagogik ta’sir ish berganligini anglatadi.

3-rasmdagi sxematik masalada muammoning qo‘yilishi, tajribani rejalashtirish va NKni tanlash ishlari ko‘rsatilmadi. Endi shunday algoritmni Z, T, KW, λ va χ^2 – NKlar imkoniyatlaridan kelib chiqib taklif qilamiz.



4-rasm. A va B muammolarni NKlar bilan tahlil qilish algoritmi.

4-rasm yordamida algoritmni tanlash orqali χ^2 alomati imkoniyatlaridan kelib chiqib misol taklif qilamiz. Bunda "OTMlardagi masofaviy ta'limda ta'lim sifatini oshirish" uchun o'tkazilgan tajriba-sinov ishlarining statistik tahlili χ^2- alomati asosida amalga oshiriladi va χ^2 alomat yordamida nazorat kartani dastur yordamida quriladi. χ^2 alomat vositasida ixtiyoriy tabiatli ma'lumotlarni tahlil qilish orqali bir vaqtning o'zida chekli sondagi bir nechta tanlanmalarni taqqoslash (bir jinsliligini tekshirish) imkoniyati paydo bo'ladi.

Nazorat va tajriba guruhlaridan X va Y son belgilar asosida N va M hajmli tanlanmalar olingan bo'lsin:

$$\underline{X} = (x_1, x_2, \dots, x_{n_1}) \text{ va } \underline{Y} = (y_1, y_2, \dots, y_{n_2})$$

Bunda o'lchanuvchi xossa $L \geq 2$ kategoriyaga ega bo'lsin. Maxsus ishlab chiqilgan qoidalar bilan $\underline{X}$ va $\underline{Y}$ tanlanmalarning elementlari qaysi kategoriyaga tushishiga qarab chastotalarini aniqlaymiz.

Nazorat va tajriba guruhlari uchun $v_1 = (v_{11}, v_{12}, \dots, v_{1L})$ va $v_2 = (v_{21}, v_{22}, \dots, v_{2L})$lar, tajriba natijalarining chastotalari, ularning noma'lum ehtimolliklari $p_1 = (p_{11}, p_{12}, \dots, p_{1L})$ $p_2 = (p_{21}, p_{22}, \dots, p_{2L})$ bo'lsin.

U holda birjinslilik gipotezasi quyidagicha bo'ladi:

$$H_0: p_1 = p_2 = p$$

bu yerda $p = (p_1, p_2, \dots, p_L)$, $p_1 + p_2 + \cdots + p_L = 1$ – noma'lum ehtimollik vektori.

H_0 gipoteza nazorat va tajriba guruhlarida har bir kategoriya bo'yicha tajriba natijalarining ehtimolliklari o'zgarmaganligini bildiradi.

Bu yerda alternativ gipoteza quyidagicha bo'ladi:

$$H_1: p_1 \neq p_2 \neq p$$

hech bo'lmaganda bitta kategoriya bo'yicha.

α qiymatdorlik darajasida bu gipotezalarni tekshirish kriteriysi quyidagicha bo'ladi:

$$\hat{X}^2_{n_1, n_2} = \frac{1}{\omega(1-\omega)}\left(\sum_{j=1}^{N} \omega_j v_{1j} - n_1\omega\right)$$

bu yerda $\omega_j = \frac{v_{1j}}{(v_{1j}+v_{2j})}$, $\omega = \frac{N}{(N+M)}$.

Bir jinslilikni χ^2 alomati quyidagicha:

Agar $\hat{X}^2_{N,\,M} > \chi^2_{1-\alpha;\,L-1}$ (bu yerda $\chi^2_{1-\alpha;\,L-1}$ ozodlik darajasi $L-1$ bo‘lgan χ^2 kvadrat taqsimotning kritik nuqtasi). U holda H_1 qabul qilinadi, H_0 esa rad etiladi.

Faraz qilaylik $L=4$ bo‘lsin. Bunda X va Y 4 ta kategoriyaga ega bo‘lib, “5” baho ($j=1$), “4” baho ($j=2$), “3” baho ($j=3$) va “2” baho ($j=4$).

Yuqoridagi H_0 va H_1 gipotezalarni tekshirish kriteriysi quyidagicha bo‘ladi:

$$\hat{X}^2_{n_1,\,n_2} = \frac{1}{\omega(1-\omega)}\left(\sum_{j=1}^{4}\omega_j v_{1j} - n_1\omega\right)$$

5) ga asosan χ^2 kartaning yuqori nazorat chizig‘i quyidagicha topiladi:

$$UCL_{\chi^2} = N\cdot\omega + 7{,}82\cdot\omega\cdot(1-\omega).$$

Nazorat qiluvchi miqdor esa quyidagiga teng:

$$g(\underline{X},\underline{Y}) = \sum_{j=1}^{4}\omega_j v_{1j}$$

Endi quyidagi muammoga qaraymiz. Oliy ta’lim muassasalari talabalarining “Masofaviy ta’limda ta’lim sifatini oshirish” uchun o‘tkazilgan tajriba-sinov ishlarini aniqlashga qaratilgan tajriba avvalidagi statistik ma’lumotlarning solishtirma jadvali (OTMlar kesimida)

		$j=1$	$j=2$	$j=3$	$j=4$	
	$L=4$	**5**	**4**	**3**	**2**	
	v_{1j}	v_{11}	v_{12}	v_{13}	v_{14}	$v_{11}+v_{12}+v_{13}+v_{14}=N$
X – Nazorat guruhi	N	**20**	**80**	**76**	**17**	193
	v_{2j}	v_{21}	v_{22}	v_{23}	v_{24}	$v_{21}+v_{22}+v_{23}+v_{24}=M$
Y – Tajriba guruhi	n_2	**23**	**67**	**97**	**21**	208

Tajriba asosida topilgan ma’lumotlar orqali quyidagilarni aniqlaymiz:

$\alpha=0{,}05$; $k=2$, $L=4$, $N=193$, $M=208$ bo‘lgani uchun quyidagilarga ega bo‘lamiz.

$$\omega = \frac{N}{(N+M)} = \frac{193}{193+208} = \frac{193}{401} = 0{,}481\ ;\qquad \frac{1}{\omega(1-\omega)} = \frac{1}{0{,}481\cdot(1-0{,}481)} = \frac{1}{0{,}481\cdot 0{,}52} = 4$$

$$\omega_j = \frac{v_{1j}}{(v_{1j}+v_{2j})} =$$

$$\omega_1 = \frac{v_{11}}{(v_{11}+v_{21})} = \frac{20}{(20+23)} = \frac{20}{43} = 0{,}465$$

$$\omega_2 = \frac{v_{12}}{(v_{12}+v_{22})} = \frac{80}{(80+67)} = \frac{80}{147} = 0{,}544$$

$$\omega_3 = \frac{v_{13}}{(v_{13}+v_{23})} = \frac{76}{(76+97)} = \frac{76}{173} = 0{,}439$$

$$\omega_4 = \frac{v_{14}}{(v_{14}+v_{24})} = \frac{17}{(17+21)} = \frac{17}{38} = 0{,}447$$

$N\cdot\omega = 193\cdot 0{,}481 = 92{,}8.$

U holda

$$\hat{X}^2_{N,M} = \frac{1}{\omega(1-\omega)}\left(\sum_{j=1}^{3}\omega_j\cdot v_{1j} - N\cdot\omega\right) =$$

$$\hat{X}^2_{193;208} = \frac{1}{0{,}481 \cdot (1-0{,}481)} \cdot \left[\left(\frac{20}{(20+23)} \cdot 20 + \frac{80}{(80+67)} \cdot 80 + \frac{76}{(76+97)} \cdot 76 + \frac{17}{(17+21)} \cdot 17\right) - 92{,}8\right]$$
$$= 4 \cdot [(0{,}465 \cdot 20 + 0{,}544 \cdot 80 + 0{,}439 \cdot 76 + 0{,}447 \cdot 17) - 92{,}8] = 4 \cdot 1 = 4$$
$$\chi^2_{1-\alpha;(L-1)} = \chi^2_{0{,}95;3} = 7{,}82$$
$$\hat{X}^2_{193;208} = 4 < \chi^2_{0{,}99;3} = 7{,}82 \qquad H_0 \text{ qabul qilinadi.}$$

Ish nazorat karta yordamida amalga oshirilganda, nazorat kartaning yuqori nazorat chegarasini hisoblaymiz.

$$UCL_{\chi^2} = N \cdot \omega + \chi^2_{0{,}95;3} \cdot \omega \cdot (1-\omega)$$

$N \cdot \omega = 193 \cdot 0{,}481 = 92{,}8$; $\omega \cdot (1-\omega) = 0{,}481 \cdot (1-0{,}481) = 0{,}25$; $\chi^2_{0{,}99;3} = 7{,}82$

$UCL_{\chi^2} = 92{,}8 + 0{,}25 \cdot 7{,}82 = 94{,}75$. Demak, nazorat kartamizning yuqori chegarasi $UCL_{\chi^2} = 94{,}75$ ekan.

Berilgan qiymatlarda H_0 gipotezaning to‘g‘riligini tekshirish uchun quyidagi tengsizlikni ko‘rsatishimiz kerak:

$$g(\hat{X}_{NM}) = \sum_{j=1}^{4} \omega_j \cdot v_{1j} > UCL_{\chi^2}$$

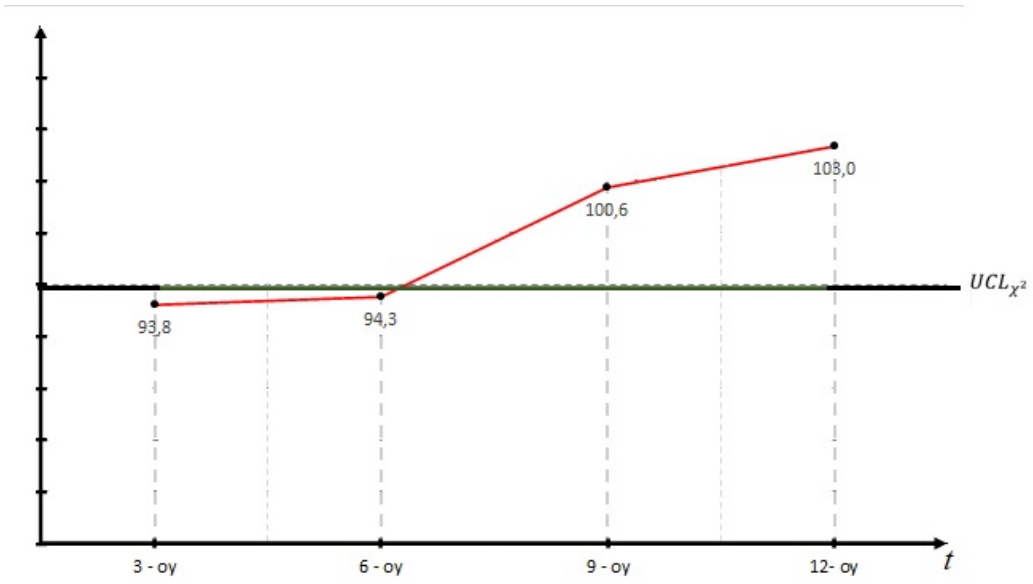
Haqiqatda

$$\sum_{j=1}^{4} \omega_j \cdot v_{1j} = 0{,}465 \cdot 20 + 0{,}544 \cdot 80 + 0{,}439 \cdot 76 + 0{,}447 \cdot 17 = 93{,}8$$

$g(\hat{X}_{193;208}) = 93{,}8 < UCL_{\chi^2} = 94{,}75$. Demak, H_0 gipoteza bu holda ham to‘g‘ri.

Hisoblash ishlari kengayib ketmasligi uchun keyingi nazorat ishlarini EHM dasturlari yordamida amalga oshiramiz va quyidagi natijalarga ega bo‘lamiz. Ya’ni 6-oydagi olingan statistik ma’lumotlarning statistik gipotezalar xulosasi $\hat{X}^2_{193;208} = 5{,}48 < \chi^2_{0{,}99;3} = 7{,}82$, nazorat kartamizning nazorat qiluvchi miqdori esa $g(\hat{X}_{193;208}) = 94{,}3 < UCL_{\chi^2} = 94{,}75$ ga teng. 9-oydagi olingan statistik ma’lumotlarning statistik gipotezalar xulosasi $\hat{X}^2_{193;208} = 31{,}1 > \chi^2_{0{,}99;3} = 7{,}82$, nazorat kartamizning nazorat qiluvchi miqdori esa $g(\hat{X}_{193;208}) = 100{,}6 > UCL_{\chi^2} = 94{,}75$ ga teng. So‘nggi 12-oydagi tekshirilgan ma’lumotlarni keltiramiz. $\hat{X}^2_{193;208} = 40{,}8 > \chi^2_{0{,}99;3} = 7{,}82$, nazorat kartamizning nazorat qiluvchi miqdori esa $g(\hat{X}_{193;208}) = 103 > UCL_{\chi^2} = 94{,}75$ ga teng.

Natijada quyidagi ko‘rinishdagi diagrammani hosil qilish mumkin.



5-rasm. Masofaviy ta’limda ta’lim sifatini oshirishdagi yangi metodikaning samaradorligini ko‘rsatuvchi nazorat karta.

Diagrammadan ko‘rinib turibdiki, dastlabki 6 oyda natijalar qoniqarli bo‘lmagan. Keyingi 6 oyda esa tajriba natija berayotganini ko‘ramiz.

Ushbu tajriba-sinovda NG va TGda qatnashgan respondentlarni biror X va Y son-belgilarining tartib yoki nisbat shkalada o‘lchangan qiymatlari asosida farqi bor yoki yo‘qligi haqidagi xulosalarni yangi qurilgan NKlar orqali tahlil qilish algoritmi ishlab chiqildi. Izlanuvchi tajriba rejasini tuzishdan avval algoritmni o‘rganib chiqsa va shunga qarab imkoniyatlarini hisoblasa, NKlardan qaysi birini tanlash muammosi tez hal bo‘ladi.

Adabiyotlar:

1. *Грабарь М.И., Краснянская К.А.* Применение математической статистики в педагогических исследованиях. Непараметрические методы. —Москва: Педагогика, 1977. – 136 с.

2. *Новиков Д.А.* Статистические методы в педагогических исследованиях (типовые случаи). – Москва: МЗ-Пресс, 2004. – 67 с.

3. *Шелехова Л.В.* Математические методы в педагогике и психологии: в схемах и таблицах. – Майкоп: Изд-во АГУ, 2010. – 192 с.

4. *Нужнова С.В.* Применение статистических методов в психолого-педагогических исследованиях. – Троицк: Троицкий филиал Челябинского государственного университета, 2009. – 120 с.

5. *Turner R.* The Red Bead Experiment for Educators. – Quality Progress, June, 1998. – Pp. 69–74.

6. ***Gitlow H.S.*** Viewing statistics from a quality control perspective // International Journal of Quality & Reliability Management, 2001. – Vol.18. No 2. – Pp.169–179.

7. *Солонин С.И.* Метод контрольных карт: [Электронное текстовое издание]. Екатеринбург, ЦНОТ ИТОО УрФУ, 2014. – 213 с.

8. *Yuldashev X.D., Yuldasheva M.R.* Alternativ alomatlar uchun nazorat kartalar yordamida o'quv jarayoni natijalarini va effektivligini tahlil qilish haqida // Namangan davlat universiteti O‘zbekiston Respublikasi Fanlar Akademiyasi V.I.Romanovskiy nomidagi Matematika instituti. “Yosh matematiklarning yangi teoremalari – 2018” ilmiy konferensiya tezislari to‘plami. 18–19 oktabr. – Namangan, 2018. – B. 39–40.

9. *Yuldashev X.D.* Pedagogik tajribalarda ikki bog‘liqmas tanlanmalarning birjinsliligini tekshirishning styudent alomatiga asoslangan nazorat kartalar haqida // NamDU ilmiy axborotnomasi, 2023. – No 2. – B. 589–594.

10. *Akhmedov S.A., Yuldashev Kh.* Statistical analysis of current pedagogical experiments using control charts // International Journal of Education, Social Science & Humanities. Finland Academic Research Science Publishers, 2023. Vol.11. Issue 6. – Pp. 480–488. [Online]. URL: https://doi.org/10.5281/zenodo.8039246 480 - 488 pp. (Date of Access: 08.01.2024)

11. *Yuldashev X.D.* Kramer-Uelch alomatiga asoslangan nazorat kartalar bilan pedagogik tajribalarni statistik tahlil qilish haqida. // “Analizning zamonaviy muammolari” mavzusidagi Respublika ilmiy anjumani materiallari. **–** Qarshi, 2023. 2-3 iyun**.** – B. 402**–**404 b.

ON THE ALGORITHM FOR USING CONTROL CHARTS IN THE STATISTICAL ANALYSIS OF DATA FROM A PEDAGOGICAL EXPERIMENT

X.D.Yuldashev[1]

Ilmiy xabarnoma. Seriya: Pedagogik tadqiqotlar – Scientific bulletin. Series: Pedagogical Research. 2024. 2 (78). 50-58.

[1]Andijan State University, Andijan, 170100, str. University, 129 (Uzbekistan). E-mail: agsu_info@edu.uz

Key words: Pedagogical experiment, statistical tools, control and experimental groups, statistical hypotheses, control chart, control value, boundaries of control charts, recipes for using control charts.

There is a general algorithm for using statistical criteria in the statistical analysis of data from a pedagogical experiment, according to which, before and after the experiment, the empirical value of the criterion is calculated based on information about the results of observations. This number is compared with the critical value of the criterion and a conclusion is made about the acceptance or rejection of the main hypothesis.

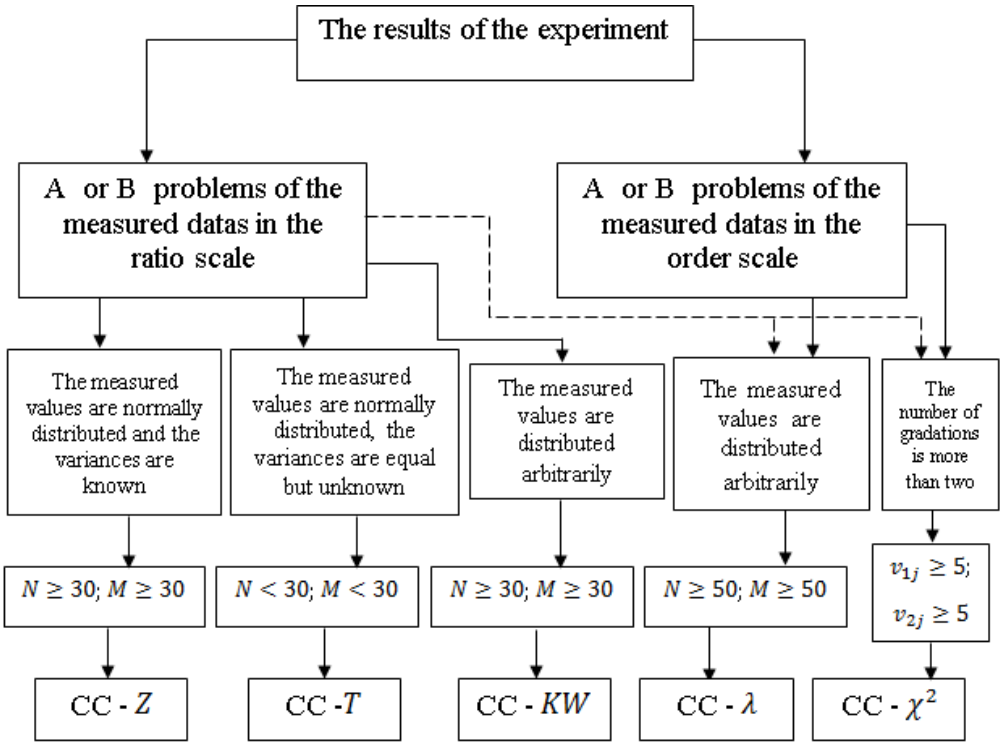
In our algorithm, the decision to accept the main hypothesis is determined by the value of the control value of the control map falling above the upper control boundary of this map. At the same time, there will be checking the main or alternative hypothesis before the beginning, several times in the middle and at the end of the pedagogical experiment. This will all be visible in the control chart diagram.

A control chart (CC) is a diagram used for statistical analysis of the pedagogical process based on observations. The main characteristics of the CC to be determined are the measured value, the lower control limit (LCL) and the upper control limit (UCL). Depending on what the main pedagogical hypothesis is and where the value of the measured value found according to observations is located in the interval (LCL, UCL) or outside it, we conclude about the studied pedagogical phenomenon. To find LCL and UCL, we need a confidence interval for the measured value, and we use the distribution of the measured value.

In the article, based on the criteria of Student (Z, T), Kramer – Welch (KW), Smirnov (λ) and Pearson (χ^2) on the homogeneity of two samples, control maps were found that verify the basic pedagogical hypothesis about the phenomenon under study.

The work provides a schematic view of the progress of a pedagogical experiment and recipes for using types of control charts when analyzing data in pedagogical research.

Let's carry out an algorithm for using CC in pedagogical experiments.



In the scheme, N is the sample size in the control group, M is the sample size in the experimental group, v_{1j} and v_{2j} are the number of frequencies by gradients.

References:

1. Grabar', M.I., Krasnyanskaya, K.A. (1977) *Primenenie matematicheskoj statistiki v pedagogicheskih issledovaniyah. Neparametricheskie metody* [Application of mathematical statistics in educational research. Nonparametric methods]. Moscow: Pedagogika.

2. Novikov, D.A. (2004) *Statisticheskie metody v pedagogicheskih issledovaniyah (tipovye sluchai)* [Statistical methods in pedagogical research (typical cases)]. Moscow: MZ-Press.

3. Shelekhova, L.V. (2010) *Matematicheskie metody v pedagogike i psihologii: v skhemah i tablicah* [Mathematical methods in pedagogy and psychology: in diagrams and tables]. Majkop: Izd-vo AGU.

4. Nuzhnova, S.V. (2009) *Primenenie statisticheskih metodov v psihologo-pedagogicheskih issledovaniyah* [Application of statistical methods in psychological and pedagogical research]. Troick: Troickij filial Chelyabinskogo gosudarstvennogo universiteta.

5. Turner, R. (1998) The Red Bead Experiment for Educators. Quality Progress, June. Pp. 69-74.

6. Gitlow, H.S. (2001) Viewing statistics from a quality control perspective. *International Journal of Quality & Reliability Management*. Vol.18. No 2. Pp.169-179.

7. Solonin, S.I. (2014) *Metod kontrol'nyh kart* [Control chart method]. Ekaterinburg, CNOT ITOO UrFU.

8. Yuldashev, X.D., Yuldasheva, M.R. (2018) Alternativ alomatlar uchun nazorat kartalar yordamida o‘quv jarayoni natijalarini va effektivligini tahlil qilish haqida [On the analysis of the results and effectiveness of the teaching process using control charts for alternative symptoms]. “Yosh matematiklarning yangi teoremalari – 2018” [“New theorems of young mathematicians – 2018”]. Collection of abstracts of scientific conferences. Namangan. October 18-19. Pp. 39-40.

9. Yuldashev, X.D. (2023) Pedagogik tajribalarda ikki bog‘liqmas tanlanmalarning birjinsliligini tekshirishning styudent alomatiga asoslangan nazorat kartalar haqida [On control charts that check the independence of two samples in pedagogical experiments based on the student’s criteria]. *NamDU ilmiy axborotnomasi.* No 2. Pp. 589-594.

10. *Akhmedov, S.A., Yuldashev, Kh.* Statistical analysis of current pedagogical experiments using control charts // *International Journal of Education, Social Science & Humanities. Finland Academic Research Science Publishers,* 2023. Vol.11. Issue 6. – Pp. 480–488. [Online]. URL: https://doi.org/10.5281/zenodo.8039246 (Date of Access: 08.01.2024)

11. Yuldashev, X.D. (2023) Kramer-Uelch alomatiga asoslangan nazorat kartalar bilan pedagogik tajribalarni statistik tahlil qilish haqida [On the statistical analysis of pedagogical experiments with control charts based on the Kramer-Welch sign]. ***“Analizning zamonaviy muammolari” [“Modern Problems of Analysis”].*** *Materials of the republican scientific.* ***Pp. 402-404.***

Muallif haqida ma’lumot:

YULDASHEV Xushnudbek Dilmurad o‘g‘li – Andijon davlat universiteti Algebra va analiz kafedrasi erkin tadqiqotchisi. E-mail: xushnudbek_yuldashevd1982@adu.uz