" $\triangle$ COMPNIATIVE STUDY OF THE MFECTIVETETS OF
 CORBIMED KITE TFACHRDMISTROCTIO: IN EMALI GROUPB AND CONVENEIOALI GLABSROOH TEACHIEG "

## 

-A thesis culaitted to the Onivernity of Nairobl 1s partial furfiment for the Dogree of Mastere of Educuticn.

## Dromarasion

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This thesis is 35 original mort and has not been mubnitted for a degree in any other University."
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PRALHCIS OBULGSMOKAMBI
write thesis has been submitted for examination with my approval as University apervisor.
2.5. Eminami

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## ACUMOLLEDGEMFITS

In the life of this study severel debts have been ncemmated. Mrat and foremost, the inventigntor is indebted to ver. G. S. Eshiwani of the Univeraity of Mairobi who has readered hin invalunble sesvice throaghout the duration of the studj. Uithout his untiring and effective cupervision, this atudy would not have been a success. The investigntor is also happy to acknowledge the help rendered to hin by DT. Andrew Young also of the Univeraity of Ialrobi, who helped in the interpretation of data. Dr. Peackock of Kemmaja Teachers College aleo deserves mention. He read the manuecript and offered very constructive criticisas and suggestions.
rabnowledgments are also due to colleaques in the Mo E . Mathenatic: Education clasa, Mr. Oyor Otieno, Mr. Okiya Toka and Mrs. Hellen Kithilnji, with whom I had useful discuasions on the subject of ny reserch.

Mention should also be made of Mr. J. D. Ornor-Onyango of the Forest Headquarters. He kindly lent me powerful dest calculator without which data analysis would have been an uphill task,
since by the time of data analysis there was hardly any money left for computer use.

I would also like to thank the kind ladies who typed the manuscipt. Those were Mrs. Mary Cteto, Prs. IUMrearet Â\}ordc and liss Selrha "akuze, ail of the jusurey of Eiew-a, Tieimnivi. Special mention should bemade of Mrs. Peresa Gaya who typed the learning materials i.e. the program and the lesson and the measuring instruments.

This list of acknowledgements would be incomplete without mentioning the research assistants who worked very hard to make the investigation at least successful。 Thanks go to Mr. Ocghieng, Adipo, Mir. Oyier and Iir. Atieno of Lake Primary Sichool, Mr. Angwenyi, Mr. Olando and Mrs.Cbunga. of Manyatta Primary School; and to Mr. Ogotai Mr. Sijenyi and Mir. Odero of Kisumu Union School.

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## (Xi2)

## ABSTRACE

Since the introdnction of 8 ree primary education in lonya in 1974, the primary sahools have witnessed an influm of pupils. sotel enrolmante rose from 24\% in 1973 to $107 \%$ in 1974. In 1975 enrolmonts wore 2881155 and in 1976 onrolmants atood at 2894617. (Sooial Perapectivess Vol. 2 IIO. 6 Iov. 1977 and Vol. 2 Ho. 3 duguat 1977). This muber vas matched by 87,076 teachers ont of whon $63 \%$ were qualisied. This gives a ninime of 52 pupile per teacher. Nor that the primery school feen are gradually belig phased out, ane can assune that the rate of drop out in upper classes will be minirised. This mean that the muber of pupile will continos to rise. If this trend continmes then the problem of finding cuitably qualified teachers will be arisravated. It is hypothenized in this study that this problen can be alleviated by finding out a gultable teaching gethod which would belp alleviate the shortage of teachers in vital subjocts, such as mathemitics. use auch mothod 1s prograned learning.

Copasisons betwcon traditional teaching and progrened learning in Eenfe have been ande 1. the secondery schools. Asong thome known to the present revearcher who have done wort in this fleld are Ehtwent $(11,1974)$ and Paxicar (12.2974). The presert etudy devfatos from this trand and looke at the euitability of proeramed leuraing in the prinery echools in Keaje.

The major perpose of the study was to find ont whether three sodec of inctruction - progremed. instruotion (PI). proeramed inatruction arpplenented by teacher inetruction in gnall gromp (IPI), and the conventional clasmroon inntruction (CI) - would prodnce different levele of attajnent and retention. In addition, the study aonght to farostigate possible relationships betwaen attaineent. and predictor vasiables (nathe ability, reading ability, attitude towards mathemetice and tovard the motbod by uhion the aubject is presoated). and botwcon attalment and retention.

The aubjects for the atudy compreod 353 pupila fro three schoole randony dreme froe all lou cost primary schools with treble etasiard six cleases in Kisum Town. In each echool, the three

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xiv )
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streane were randonly asalgned to the three treatments.

After the adniaistration of pro-testa
the groupe were subjected to the three different treatments followed by a post-tost. Eight weeks later, a retention test was administered.

In most respects, a two-way analysis of covariance showed no algnificant trentment offects on post-test achievement on knowledge, comprehension and application rubtasks. Sigaificant treatment differences, however, existed on the analysis subtack. Ho significant treatment effects existed in retontion/all levels of cognition.

It was found that no wide differences existed among the three treatment groups with regard to the variables exanined for the prediction of post-test achievenent. Mathematical ability and reading ability were found to be elgnificant predictors of achievenent for the IPI group. Attitude towarde mathemation was good predictor of achievement for the subjects in the IPI and CI groups. Ho aignificant correlations were found between attitude towarde the progran and post-test.

The post-tent scores were abter predictor of retention than prontent ecores for total scores and for each cognitive lovel. The initial pre-test scores alenificantiy predicted retention for the PI group while post-tent acores predicted retontion for IPI and CI groups.

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## OUNPER OTE

2.0

## Inchandeniol

Rocont rofome that have taken place in both the primury and socondary achoole in Kamp have veanily com from ortalde the schools. Chancee have noxmily bean introducod without fimilng out what pupils and teachern loel about then. For araxple, the introduction of the Rexpa Primary hathematice booke wa dom rithoot maving carried out proper research to doternize thotr sultability for our primary achool children, and without haviag eivon tenchere oupicionet trainiss to amble the to handio the now mathomatics courcee mith solative eame.

Kame is pot ulom in experiencing suoh problen like chortage of properly trained teachare, overcrowdedense of the mobools and inadecuste facilitios and equipmant in most of the prianty achoole. The maber of pryile in the primary achoole increasen evory jear outmubering the outpert of trainod teachore thereby giving rlise to a laxger prilinteacher ratio. This bringe about the problem of meintaining the cuullts of teachinge

In the light af thooe problens that wo seo toder in our mobools it is nocereary to senrch for now approachan to tecohing that would holp solve anok problew. One euch eppreach is proçremed loarating. Progranad leasuing has boen introdnced in man coutries, motmbly, the water countries so
(1) holp aleviate such ducstional problem lise shortege of sultably grailifod teachore and the evercrondednose of the schools and,
(2) to bolp the children meot the edrentiomel objoctives of thats oomtrion.

Athough several researabue carried out in the west have sttented to the ganeral elfoctivenone of the proisen an a Enthod of instruction and tho beve pointod ont tho obvions potontiallty of proijsenod matorlals in the scbools, auch a potentiality han not boen demonstrated in Eonyan prinny nobuo2. Apart froe Iehivani's atud (2974) which compared three modes af inutmuction procranad instruction (PI). integrated prosromed inetruction (IPI) and the cosventional clasmroon approach (CCA) in Komynsecondsty echools, and Perterels etvar (1974) which mourght to find ont whother progren-d vortoardy can bo of alenificant

## - 3 -

valme as a mothod of ingtruction as ocmpured to the formal clararoce method in the encomdry echools. Do etudy known to the present investigator has been conducted is Konjanprimary sohoole to ectablick which mothod ( B ) could be zore sustable. 2wis fact has encouraged the inerestigator of this atuds to investieate wich of the three sothode:proctmened inatruction (PI), proermined instruotion expplamented by teachor-aporviaion in mall eroupe (IPI) and the cosventional sode of instruction (CI) can be a more effoctive lensaine imetruenent for ouf prianay sebool chilarean

The orfotine of progremed learning 80 baok to the vork of Budrey Preseg (in the $1920{ }^{\circ} \mathrm{n}$ ), Hrofescor Bor. B3dmar and ire Rorman Groviler (ls the add 12 rtics). Sholis wort on the coperinont: with tenchims mollage cime about 00 a result of the diseatisfactione with traditional method of leaming, shortage of elilled teachery and by the compotition of edvances.

[^1]enalyale of bobavious oould be appliod in the conotruction of a touchsog mohtre which would preacet a anviulls sequogcod set of zaterlal to a intedeat and reluforce he responsee to direct bohaviomel capebilities (1.1973).
 esu the developmant of ilnear programe. B6 thoory contros around rovards, which in a dovelopmant and an expanelor of Dr. Ahormalke ${ }^{\circ}$ vort. Thena $(1,1963)$ seec स्VWharde as a meane Of onsuring that a particular moponse is 11 voly to te repented. He hae cited the follouing chareatoriztics of progromed learning that reader it iffermentron the eonventional =athod.
(1) Hegerend Leimaing is an todividunt Lompone procee in which the atudent ncoppts a fer vidor mondur of repponability for hle ond lournigg and proceode at his own sate.

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 porepective. London ublicity ijervices. 1953.

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(2) Progen ind lenraideg reguisos an active regpoen 850 the stmdent and providen 4 modiate confination of recults.
(3) Progrined loarnixs comares that the etredent is aore often aucconeful, and is thasefoze atrougiy notivated.
(4) the aubject mattor is progromed in ouch a way that the atudert's Lourning (behaviour) is ehaped in a particular uavo

Koat pajchologinte belluve that more leanning and rotention take plece when the learaur miker reapomsen and have ther imodiately conflized. $\mathrm{Prog}_{\text {gramed }}$ Lemering hat ane impertnat charncteristic in that it pornite the leamor to progreas at his our pace. This renoven the boredon that ia sometimes experiencod by alow learnere whan thoy have to work at tho amo pece with facter lenrwore in a conventionally tamght clasasoom.

## 

The proble of linding a exitable toaching nothod that would anable childrea in ore prinary sehvols to moet the eduoatiomal
objoctivan eat by the Kange Institete of Fiducition (a body in change of curriculv davalognart in I anga) contimen to ocoupy the ninde of many educntorn in Xegy todigy. For edventors to recomand a mothod of instruction to be adopted by schools, lts effoctivepase goode to be ascortained throngh research. 270 presont atudy, therefore seoke to lind out nentbor progrened learning cas be a mare -ffoctive leasaing instrument for our primary sebool children than the cocventional method. Spoailicaily, the problen mas to inveatignte whether Lenden prisary sohool ohildren leara and retain better whan they receive individunilsed progrend inatruction, (PI), when they receive prograned inatruction cupplemented by teachore auperviaion in mall groupe, hereimafter called the Intograted Programed Instruction (INI), or whan they lean thrungh the conventional sode of instimetion (CI).

### 1.2 RUROSTE OE MHE SKUNK

the major purposes of the study wores
(1) So investiente whother thore would be and cohioremant difforences in a unit an probebility anoor the progremed

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ingtruotion (PI), the progremind
inatruction oombinod with tenchar aupervised manll हroupe (IPI), and the conventional
instruotion groupe at each of the follouthes cognitive levela.
(a) booulodit of speaific facte.
(b) ocmprobension.
(c) applicition, and
(d) analyuia.
(is) 30 investigate methor performance in patbentios is related to sex.
the subordinate objectives of the study vore as followns
2. So sind out poasible differeaces is rending abillity arong the PI, IPI and the CI groups.
2. To inventigeto posmiblo difforences in attitude towarde mathomitios mone the threo trastmat groupa.
3. To imeoticato any difforencos is attitude towards the progren between the HI and the IPI gromps.
4. To levostigate ponaible diffureaces in setoation of probebility concepts anong the three treatmeat eroups.
5. To Luvactiguto vbich of the following verables would be vilid prodictore of cohimenoct in probabilityio readine abil1ty. Ettitede towerds Enth-miniong attitude towardd the pergrim, and Enthentical reaconirs ab111ty.
6. To immontifate uhich of the following would be a Falld prodsotor of setentionse protost cohicvenont or ponttost mohiovenamt.
7. To insectigeto posadble differenoes in methomation ab1115y.

## 

The fallowing hyothesee, stated in the rill
fow wer teatodso
2. $\mathrm{EO}^{2}$ there ia no nohiovement difforercee in test scores as monpured by probability post test.
(a) acons the throe troatment Exoupe (RI, IPI and CI):
(b) between the two ser groupt at each of the Sollowing eogntite Ioveles
(1) foowlodge of speointic facts.
(15) comprobonsion,
(1i1) applicntion and
(15) andule.

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2. $\mathrm{HO}_{2}$ : thare is no differemces in attitude towarde antlicensicn.
(1) cong the PI, LPI and the CI Eroups,
(15) betwoen the two sex groupe in the atwd.
3. $\mathrm{HO}_{3}{ }^{2}$ mpare io no differvace in attitude towarde the progren botwees
(1) the PI and the IUI growis.
(i1) the two eox groups in the eturity.
40 $\mathrm{HO}_{\mathrm{n}} 8$ 2tero is no difforunces in readins ability ac dotervinod by ijchomnol1'e poading ability seat A.
(d) erone the three treatmont exorpp.
(1i) botween the two ace !romps in the stady.
S. $\mathrm{HO}_{5}{ }^{2}$ Thare 10 no difference in mathomation 000res
(a) mong the three inntructional exoups,
(b) botween the two sex groups in the strudy.

(1) mons the theee treatame exoups.
(ii) between male and female prpils.
4. $\mathrm{HO}^{2}$ there is no correlation between propila'
(a) readise ability.
(b) attitudes towned the progrea,

$$
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$$

(c) attitudes towasd mathematice,
(d) Eatheration reamonigs ability. and thair wohieveasat in probability pont-tent scores.
8. $\mathrm{HO}^{8}$ There is no cosmelation butweed pupile"
(1) Pro-test aohievement soores,
(14) Prost-tent achiovenont scores and thair retontion scoren.
9. EO 8 thare ie no ahlevemant diffarence is 9 test scoren as menaurad by probability preateat
(a) anong the three treatuant Exoups
(b) betwoen the two sex groupl at each of the folloulng cognitive leveles
(1) mowledze
(11) ecmprehonsion
(iili) application and (27) anizaí.
2.4 trypravions or wis seuny
som of the linitations of the study asere

1. It mas not posaible to conduct a countryide atudy due to the puture of the problea and to the ting evallable for the study. Bence the subjects for thia study wern 1 inited to standand aix preyila in three troblo-streaned

## - 11 -

choole in Klana toung
2. The propls who did not ait for all the teate voro allfontedfron Mol anuluis.
3. It not posaible to cuploy the carviced of tenchers of the ene grede in all the serple soboole. Nor yan it posalble to have a sbucle teacher for all the three 1antruothomal groupe in onoh mohool.
4. It mas not posalble to cantrol far teachar enthasiana apd compotonce towneda and pastioular motinod.
5. It un 11 Ifscult to control for mestal or crotional state of sech child.
6. It was orlcinally proponed to mosure tin taten by cach child to complete a progren. Bowneres soe inotmectore did not comply mith Shi inntruotion in the fixet two dare of tho inmatigation. It was tharefore deaided to leave out the tim veriable.
7. It wan not acoortained whother the gruaps in each eceple echool were intellectun115 couparable.
8. Pupils had mare experience with the traditional entbod than the othor two at the etert of the seseareh study. This was bejond control.
9. It was diffioult to mecertain the degree to which a teecher ma able to notivato hile perpile, eapecially whea they orne to soction thres of the progran and the leason whioh noeded abstract thinting.

1. 5. Assumpriont
1. gince the tank leaznod involvod some experimental aotivity by all pupile in onok of the three groupa, it man asemed that there would to $n 0$ differencen in the motivation of paplio of all treatente. In fiew of the feot that all children wesp involved in sone experimantal activity, it was further agsend that a teachor's age, grade or experkance would not aignificantly affect the porformace of has papile.
2. inn progrenat materiala in probability coverod surficiant matorial to be learred by the etandard aix papile.
3. The teate uned wore valld and reliable.
*. The rubjecta in the etudy were asaunod to be at the sens level of molerstanding before the loveatigation bogan alince nowe of then had prior exporure to probability.
4. The sample cohools were ascuad to be coperable in lenohor diatribution and materia susply.
PROGRAMMED INSTRUCTIONThle ia a tochoiguo mesaby atuclente etudyfrom
individuuls/eaquantiall arrangod matoriale.
Progirend inetruction is nounly ahractors
facd by acli-imatructicnal, self-pacedevuroces of chort questions and anmerswhoch aro pregunted in tuaching machinotor as prozzeren textbooke (2,2973) -
5. Inteipatic: Progrphned InPMaction (IPT)
This is a technigee whareby teachor
lostruction eyplanonte the progreme.
6. Comventionn Ingtwation (CI)
This in a motiod of instruction oharacterlsed
io tenchar lectures. dematratiom and
homeroxt.

## 2

Rocbeck, If Prames from Ibadons Proizninod Loaming in a Heet Rlgorime context. iullotin or jro Trumed Ienzing, Becoarah Unit Dept. OI造Ucition, Aucuat 1975.

4- pheoryery Langinge thale refere to those toaching aituatione in which the atudent sohieren the instructional objective with 2inited of no holp from the teacher. If the leamer comploted the tack vith littlo or no guidance, be is ald to have learned by discovery (3.1973). Sometime Iearning by diecovery ocours when childeren are led stop by atep/the teacher apprepriate quastivaing and activitios using concrete materiale to diecovor concepte for themaives ( 4,2966 ).

3
 2onswod Mythetio zonclaes. Vol. II. 1974.

4
Glacer: Tiod "Varlables in piscovary Loarning"
 fearning by Diacyemil a critical Appridel. fand thenaly und coos Chicago, 1966.
5. Rainforement:-
Nccording to Pool ( 5,2963 ) roinforcenent
means the streagthonims of any "oo-going"
behaviour by a conser;uent event contingont
upoe the behaviour. Ho liste what bo ealle
the oomponents of the "aimplet reinforcing
-tate" as-

1. a perana carrying on observable bohaviour
1.8. the leastarig
2. the learneris condition of neod or mant.
3. atrengthoning ovant, 1.e. reward.

## 5

Peol. Bo dos some Paycholoical Empoiplne moderljing Progre od Inerning. Fiducationa Remserch Vol. 5, 10. 3. 1963.

## C:APMER SWO

## QYyTEA OP RITAGED TrHEGUNURE

The ais of this ohapter is to review 10 of the reaoarth firdtrge in areas of progryomed Lourging that are related to the prcsent studr. Amont tho menorous kurebtigations that heve boch mode rainting to procrmand learning only ten mont related studion have been cited by the ferestigator of the preacat etudjo Pow of those are iurectigation ancried ont in ferica while the menining alx have boen carmed out in the wort.

4 cood mour of rebearahes done in the fleld of proground le ming beve compared progrend learaing with oomcational learningo Ean of those sesuarahes have mportad tho experiozty of progranmod inntruotion ovar the cosventional mode of lnetmetions othere have fored the conventional instruction to be enperior to the progrmind inotraction whilo other buve reported 20 dffforonoos botwecm the two inmtractional nodes.

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Mandol and thardoch $(6,1968)$ compared learaing frem a prosmon text ulth learnige sren a conventional text covering the semo Etorial. ine major prippes of the atudy was to dotorndise mich of the two sothode of tenching would lead to a botter performane on - content exalination.

577 etwdente enrolled in an introductory pajeholog at Chepel 1811 comprised the subjecte for the atudy. Two of these studente were dropped for boing suppoted of ahsuting in an conndontione suis loft 575 studonts for data amiyals. the arbjects wose acalgrod to the corventiand and progrmad sections, with ach contion having botvoen 18 and 26 students. 12 inatructors, 5 fomale and 7 male gradrato studente took part in the experimant. Each Lavtructor tought two acotion - ane prorrsuad inatruction castion and one conventional instruction soctiono Ime texta wore msudi oon by holland and Sidinner and the othar by gedmeor. The progrened and courcmiond texte wore wattea by the cem author.

At the and of the course the aubjects mare
adiniatered a 100 - itea teat on operant paychology. The itean wose trken frea a large pool of itome that bad been contribated by the tecohing asaintants. The itens mere categorised into objective and ascan type items. The objective type iteas wore eubdivided into alr ontegorica, viss mitiplo - choice format (ic) ; knoulodge of apeaific content ( 1 ) s reapending to now concepts and principlea (B)s remponding to
 and application to everyday lifo (D). Thutivariato 1- ratios compated for tbe six objective item types revealed 50 evidence of a sex offeot (7) 7.300). The botween - sootructor - within sex effoct was statiatically aignificant ( 8 Lo010) 。 Fourdock (note that Willien J. Daniel died before data andjece yore completed or the roport writtons Ee, bowever, initiated the rosearah) attributeo this algaiflicance to the fact that ench instruater targht both the programiod and coaventions soctione. This, in hil viow, increnced the senaitivity of the experimont. the textbook effect was aso found to be etatiatiouly algnigicant ( $P(6,02$ ), an

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indication that a a sot, the objective measures differed eccording to the kiged of textbook atodied. The resulte of the mitivarlate F-tente for the equality of tho moun vector for the essay iten were efililar co thom for the ofr objective ltam typen. Thore wan no statistically algnificant sex effect. (P 7.422 in the first analyais and 270250 in the second analrnis). Howevor, the betvece instructor - vithin - sex effect was statistically algnisicant ( $P / 0001$ ).

The hpotheals that learaing from the progrmand toxt is greater than lemrning from the convonticanl text covering the ame material vac apported by the unirariate Potesis. In this atudy. the progren ed grum an the average obtained - 10\% higher scor on ench mitiple - cholee Iten type and a 7 M Mithar soore on each easar type item.

It should be noted that the greater learning the
diom by'jrocraned ingtruction zrove mar be atcinbed to the metiod of inatructione the contente coverved by the two booke wore asmued to De comparable in atyle, diflicults, and cantent, etc. since they were mpitton by the aan muthar Ior the san perpose. Purthor, the teaching
asalatante were vary fandiler with both booke. After their metinge after responding to a guestiomaire given to them, the instructors wore of the opinion that the texts wore comparable and the expmination adminletered to the mesearem subjects did not favour any onc text to the excluaion of the other. Bince the texts mere found to be comparable and the exmination ral not biased in favour of any one toxt, the author. therofore, conoluded that the experiment provided a fair comparison of the practical usefulness of the two toxte by Skinner, and that the proerreased toxt was nore offootive for teachims operant paychology than the conventicen text.

It ie not clear from the repert to what extont the progrined and the convontional teara covered the mam inotruotional ground, thoureh the report indicates that the two texte were comparable in style, difficulty and content alsce thoy wore both matton by the sem author, i.e. 5xingor. for the sme jurpese. The report doen not make it clear whother the lovel of motivation wae the san for all instruotional groups.

In the 1961-62 school yoar, Baghtart.

et al $(7,2963)$ anmilod out an experimontal study of progransed vermo traditiomal mothod of lantructions the purpose of the etudy man to compare programod metoriale with nonprogreme sateriale in elementaxy achool satheantics. Specirically, the study aimod at ilnding out poenible differmene in total arktheotic seores, problem colving and comprobemion betweon the two instructional groupa (prograned and coasyentionel) and between tho two eex proups.

The study was conducted in the forfolk, Vinginia. public achool aysten. the subjects for the study consiated of 295 control and expurimatel sourth-grado ohildron ropreaenting as accoptable cross-section of fourth greder: in inteliligence, achievarent, and sociomeomonic etatus. The aubjoots were in a relativaly superior sohool in terme of facilitios and persomond.

The experimontel class loamed through the progne while the control clams learest througt

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$$
\begin{aligned}
& \text { Banghart. Fo W. ot } 48 \text { an expaximenteil otudy } \\
& \text { of Programed Varnm Irralitional } \\
& \text { Elcmentary Ichool Mathuantles. } \\
& \text { NMthotic ioachar. Yoi. No. S. } \\
& \text { 2953. pp. } 199 \text { - } 207 .
\end{aligned}
$$

the regular matoriale. Tho progromed materiale conadsted of apocially progrownod toxt books which included the umal eoguence of fourtb-grade arithatic, eldils and content, lamuago of sots. zomber 21 mos, and simple equations involving one unknown the experimantal materiele wore oomutreoted by the author artor meking an extenaive aurvey of the content of leading - lematery achool aritheotlo toxt booke and the arithmetic corriculu oxcmalisation is sovoral Inrgo school aystcm to nssurv that all the major aldile pormily tanght at the fourtb-israde lovel are properly treated in tho experiment.

The control materiald for the control sabjects consisted of the atandard text and mupplomental matorinis used as a rogelar port of the normal instruotion in fourth-grado arfthotic in the FIorfalk, Virginia, penbic school eysten.

The length of the normel clans poriod for both the experfentel and costral classes mes 30 - 40 minetes a day. The author met ecearionally with the experinaatel teechere to discuas shotr observationa in the alasarocm.

A b-test was computed to compare the pacformance of the experimantal and control nubjects. The differances between the experieental and the control groups for total scores and comprenenalon ecores (total, boys, and girle) are algnificant.

The differesces betwoen the two groupe for problen solving (total), problen solving (boys) anc problen solving (girle) are not atatistically signisicant (ing 05). The author ettributes the non-bignsficence between the groups for problem solving (boys) to the large mount of varlabllity between the groups. Mo reason can be edvanced for the difference between means for problea solviag (girls). The suthor finds it interesting to note that the eaen score for experimentel proble solving (gisis) is conalstent with the other experimentel acmes.

The general observation by the experimental teachers wes that the childaren in the experimental groups showed high enthesiaen for the programed eaterlals. The experimental teechere felt that learning thsough individual eelf-paced prograns vee - very effective mens for tesching elemantary school arltheetlic. The teachors also

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noted certain disecvantages assoclated uith Individucilmed learning. They noticed that when vorking with programed eaterials. pupils quidily covered o uide range of content unich threatenad to incrense es puplis aovanced throuph their progranmed material. Thay also noted that the puplis did not work at comstant rates. rathor the rates at with some pupils morted vas erratic. Thls made it mecessery for the teechers to keep a dally record of the progrese and apead of cech chilo. Infect the lect of constancy in pupil wort constisutes one Of the edvantages of individuallsed programined Inotruction for tho clow learners who would otherwise te bared 18 they hed to learn at the sem rate with the fast learners, anc for gast learnars tho mould be relleved from the Invotraticns of belng detalnet by the siow learmars. Teachers noticec chileren foning voluntary groupe to discues the pregran.

The author cbserved that if programed materlals ere wall denlgned and vall-tested and 18 competent and Interasted teachers are employed to mipervies progranned leerming. thum one can expect algnificent achlevement in
favour of progrumed meterials ovor conventional natoriale. Amother neerul observation mace by the author is that progrtan should be integrated with the teachor. It contends that programed nateriols are mont offoctive when used to supplement the clasmxom teaoher.

Jomiosan ( 8,1969 ) investigated the relative offoctivenoss of two methode of inatrection - programod and guided: M1scovery mothode and the offucts of the aame upo people of difforent age eroups. (This researeh is related to the preacme study in-bofar an the comparicon botwoes the progrened and the gulded discovery methode in concerneds otherwise it is not, since the procest study is not invosticating the effecte of difforeat instructionel modes upe difforant age groups).
8
Janioson, Go Hos Learning br Programed and
coulded inecovery hethoda at Dirforeat
Ago Ievols. Prorrammed Learning and
Educstional zechnolory Vol. $_{6,1969,}$
ppo $20=30$

The subjecta for this study consistud of 80 fcmales categorised on the basis of their see a followit -

1. 20 prapile drawn from a state primary achool 50 ago 11, rage 10 joara, 1 month to 11 yeare 8 months. (This was the jounesest (6xOm).
2. 20 stedante frem a college of ocoupetiomad therepy, man age 21 , rame 20 yeare 8 monthe to 22 joare 11 month.
3. 20 atudenta fro a college of education for mature stuclonts, mean ase 40 jeare 6 monthe. ranee $34-47$ yearm.
4. 20 mombere of tho Liverpool Medical Research Council's voluntary panel. man neo 57 jours 5 moatha, range 51-66 joasm.

These subjocts wore randonsy aselgned, in ocqual monbors. inthin their ase groups to the two difforant sedea of leeraing 1.0. programmed and guided diacovery. The proctramed iscoup went through a 254 - freme limaar progran on binary momber, presented on meall mamally oporated teaching machises. The subjocts worked independently, bet in the presence of othere in
thols group. No tim lingt was specifiod, bet a reoord of imifvidmal time to coupletion was covertly kept.

In the guiced diccovery method ETOUD each subjoct wee previded uith o binary light lindicntor and binary/deany courorsiun sonle epealaliv dosignod for the exporiment. Tho rubiects used these leamine alds to disoover the bane of the binary ayeten, and to neke meneicnl converoion betwean tho binary and denury 8 gstans. The content taught wan the samo for the two inetructionel eromps. 1.e. the proysurind and the gaided discovery eromps. The sped of the lesson depended in the mbjects' Feapome and the leedback needed to olerify 0 polete et 1830 .

Before the beginaing of anch course. Voswen'e grored-arithmotic metbention sogt was mosinisterod tc all the mbiocts in the stedy. It tho end of onot ovrrac all the rubjects were adriniaterad a mitton tnst in binury mumes. the teat aerplad all the wort in mubber vilch had boan tauribto

A IVo-point acale attituie çuentionalio vas adrinietered to the subjocts to sample the
subjecte" remponver to the loasning aide and to ellait a oomparisan botween the prouramed and the guided diccovery mothode.

The data obtained wore aubjectod to the Hanm-ihitney "f゙" teste and to rank-difference ( 5 OO) correlatiuns. The resulte of the "O" teata ahoved thatz-

Gabjeotn in the youngeat and oldent greups. 1.0. groups 1 and tho learned by the discovery method performad al gnificantly bettor in binary opiterion tost sooron ( $\mathrm{P} / 0.02$ in both omsen) than the other subjeots in the anmo estoups who learned by the prorgrumed group (2). The programed mothod subjucts in the seme eze groupe 2 and 4 mare aignificantly çuiaker then the subjeots in the anme groups learaing by the guilued iisacovary menthod (P\&0.002 in bott ouncs).

Bank difforence cor-elation coefficients wore compted for arithentic scores and bimary oriterion soores for arithentic test acores and learaing tico (binary); for ace and learning time (bimaxy)s and for ago and binary cxiterion sores.

The realle showed a signisicant corrolation botwan axithnetic ability and scores on the bleary oxiterion test (PLO.01 for the protramed group and a ágnificant positive rolationohip between age and time ( $P$ LO.05 for the programed (eroup). Ho sicalificant melationahipe wore found between mes and bimury eritorion scores for both the progresmod and the guided discovory eroupse

2te foregoing diaenacion of the resulte stion that the powneat and olceat [rompi using the guided discovery method performed better in binayy cxitorion scorse than moubrra of the sam groups learaing by tho other method. The author advances thswe reasoss $\mathcal{f o w}$ the bettor performance ahom by these two groups under the diecovery nethod:-

1. the role of the tencher. The author aremed that the supportipe pole of the teacher may have banofittod the niftheetically lose able subjacts.
2. The prisoiples of the mumber ayatom could have been more masdily graeped under the guidod discovery mothod than under the programed lastruction method.
3. Subjocto in thase Eroupe hud not developed an independont learning atjle to asaist the cope with the teaching machines.

The siryt reason adranoud by the author since does not soen to be comvincing/the report doos not isdicate anwhare that embers of eroupe ane and four luarning by tho discovery mothod were apitmotionlly loas able subjects. The reason for this axpilise auporior perfoxmance in therefore to be found elsowhere. It could bo that the guided discovery method ghoups ware sore motivated than the programed groups of the -aso ago groupa.


#### Abstract

An intorentife finding was the stronser association butwees arithatio ability scores and post prograumed learning scorve on the ariterion, than betweus arithmotical ability scores and post guided discevery leaming. Thia markeata that tranafor wa prouter for those learnisg by progran.


Stuaien an progremod iuarning have not onky involved comparimons butween prosmaned ingtruction and conventionas inutruction but buve also gone furthar to inclade a aor element, that is, the teachur and the proerem. In his comparative study of progremed anal treditional elemantary Eathonatice, Daghert $(7,2963)$ obeerved that
"allowlot procraznod materials to becom the colo conre of inctraction to the ercinsin of tho Seschar does mot mive mont offootive uce of the progrend matorinl nor of the tachor. Procranend Eteriale un most elfoctive whom nsed to amplunat the alassram tenchere"

Moadowarort $(9,1965)$ conducted a eomparativo atudy of the textbook method and the progremed conbing with tecoher instrwotions

The subjeota convisted of 298 intedeate of both seace in the eoventh grade of ULUkinslares Junior High flehool in the joar 1962-63. In the provion jerr. i.e. in the alrth grade tho alojecte lonreod by the convoational mothod. The oxprimont mae oxtondol into the 8th gende whea the aubjocts lensmed argain by the conventional method. Durimy this tim the acmplo aieo had reduced fico orkgisel 294 is the 7th grade to 249 in the 8th grade.

[^2]The phrpose of the atudy van twofalds
2. to kivestigate vhich of the two methode pregrend or conventiomel we more -flectivoz
2. to find out whothor the utilisation of progremed matoriale in the novonth grado had as edverev effoote on eleftith-grade schispement whan subjecte egmin Ieumed by the triditional textbook method.
the experimontal froup, conotitutine ono hall of the studente in tho severth Erade lonsiod arithetia by manc of tho prozre muplamonted by teacher instrection shile the other mali. the control olaus learned by moina of teachors textbook enthod. the apperimentul हुणup used the procymed entorials \%os of the clase timo and recelved tenoher inatraction 30\% of the clum time. the experimencal group lenriod at thelr ow pace and were individvalif teated. The pupils in the control froum ware inet-ucted by mane of aseigneante, lectures and seeltution.

The t-iteste cosputed revesied no significent disference botwace the mane of the tan fnatructi001 Erompe (total). But when the t-taste viro

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computed for the accolerated, above averace. avorage and slow aubrroupa, the difforance betwecn the mans of the experinontal, and the control isroups in the accolerated section man found to be aignificant ( $\varepsilon=3.33$. ( P Lo01) , with the mons for the aocelerated section of the control group ( 10.3 ) beling highor than the mann for the accelerated scotion of the experimatal group. 121 the mean for the other soctions of the two instructional frompe wore not signiflicantly different. Bat on apecial achicroment test averace section of the experimental group had sifnificantly higher man then the average of the control group.

The roaule of this study indicate thut prograned instrustion was not auperior to the textbook method an far an arithmotic emhievement wa concernod. However. programed Leaming was found to be more officient in saving atudent tive than the convontions method of lurciuse

Shes sopmrate seotions of the expersisental and control groupe were considered, the eccelerated section of the control froup was Sound to have a dignificantly Megher mann then ite counterpart in the experimontal acction.

The author attribeten this differance to the Taco of antorials bet pot to tho proceramed naterlal themolven. 2ais indicatee thet the accelereted ecction of the experfmontal Group did not make proper use of the progremed netexar.

The atthor puts lorwand atront case for molos progranmed mterinle when to comaldored total advance by the studenta in teren of nchievenant; the experimontal E5TOUP edvanced 1.3 Ferse mile the control groum advenced ouls 1.1 Jence.

An intereating point to note in this Luventigation is that oducatore cen insert without progranad materiala in one Erade/roconeurily Sollowing it up in tho nost grude without antloipeting dire mealite. zhle follow imon the fact that nee of the programod materiale In the seventh grade did not very mach arf at achlevenent is the 8th frede when tre wyperimental grou: no longer loismod by the progrmene.

It in not clear lrom this investigation Whother the tent reed to mencure retontion in the eiEbth grado was the wane test adrinistezud to the aubjecta in the eovonth Frade. It is
frecther not clear whother the two expops in the study wore tawith by the sane teacher.

Anothor study on interrated proernamed loaratng mat by liolubery ( 10.1966 ). St compared the corrontional classroom method with a conbiantion of procramed instraction and tancher auperrised anill grox inotrustion in the seventh srade.

The subjects wore 19 boya and 27 girls frem two elassee at the sshool of Fiducition in fialmo. Ewoden. Each clase had 18 puinis, mubdivided on the basia of thoir mathonatical and intellectun abilities into a high a aiddle and a kroap. with each group conprising oix pupils.

One clasa received progrmmed instruction eupplonanted by towhormerperviaion in mall groupa, ranging fzo two to alx proile por exoup. Time for group instructions ranged fron 20 to 20 sinates. the control clane rocuivod corvontional instruction whore the teacher propared nev iteme on the blackboard and the jropile given exorelses to be dwe

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Koleborg. Ios a combination of protrmanec inmtrection and tencher - supervisod ennil group inatrection compared with conventionnl claseroo mothod MMMTrety (Mnlon, Bwe dens School of Education). 1986 No. 10.
in class and at home. Tosoher made tests were given overy monh to teat for achiovenent. The two lastructional iscoups were taught by one teacher.

Before the start of the experiment eubjeots were teatud with the Cattoll Culture Pair Bonle 2A to ind out whether they were intellectually comparable. The resulte showed no difference between the progremed ingtruction group (mean of 26.85 with a stapdard deviation of 6.81) and the conventionil instruction grone (man 28.44, standend doviation, 4.58 , P>0.20). To control sor the arithetic ability of the pupile thej wore adninistered a 10 - iten arithotic test. The resulte vere not statistically sigalficant (FI clame, $x=2.72,8-0.96$ and CI clacse $x$ - 2.83. S-0.92, P>.20).

The pupile were divided into high, aiddle and 10 w Eroupe following their scores on intelligone toyts and mithmotic tosts.

Chances in amithaotic, reuding ability. Clamaroom bebaviour, play and pasaivity. diaturbinc iatoractions, working hahitn, proforase for aplthatic, wore amiyaed. in analyaia of vartence revenled no alcaificant dilfermen in axitheotic sohiovement botweon
the two instructional eroupe ( $P>0.05$ ). But variatioa botween high, niddie and low groupe wae foum to be algnificant, with the high group eettine the beat rearults and the low group tice poorent ( $P<0.001$ ). The rosulte of Fendine mbility, invantleated once a scmentor with Dlagnostic reading teats dealgned by Dr. Rese sioverion at the Sobool of Bducetion in Stookbolm, Bwnden, revenied some changes in rendiaf tochaique. Pupils decrensed in rendigs sped but gaised is comprohonoion. The experimental elann dioved ulguificant muperiority in reading instruetione and toaded to be more independent in their laboratory work then the oontrol clase. There was a algnificant dirforence betwoon the two inatructional groups in the variable "disturbing internotion", the variable boine frequently moted in the ountrol clase ( $2<0,001$ ). chansroen behaviour was found to be rather sfinder in both clesser in apste of the difformat teaching mathode being exploged.

Though the study shows no ovidence of the euperiarity of either method with regards to arithmatic achlevenant, the dategratod prograimed instruction gaing over the convontions
instruction in reading ability tost. The
integrated progranad loumaing group is shown to be more independent in the Ieboratory wort than the comrontional Erowo.

The prple' attitude towarde the prograin ves not vory pronioing. ste pupile found prerrened instruction more tirise thme the conventional sontruction. fut thoix feaesul cpinion mes that ther leazped more from procramoed materiale than from convontional materivis.
the two factore mostioned sbove, L.e. that the pupis of the progrennod instruction ETOU showed more indopendunce in thois woxt than the puplis of the canventional irstruction froup and that the pupdis of the procranmed Inntraction expressed the opinion that they Iearnod Fore frcm procranand materfald argue well for procraned leasning to be introtnced in a
 teachers are in ahort angpizo

Comparative etudios involvins prozranod learains and convantionsl instruction bave elso boen carried out in Afmica. Avong the researahery who have done work in thin flold in fichen ere

Tishivan ( 11.1974 ), Partar ( 12,1974 ), Ohomrotifa $(23,1968)$ and Rosbock $(14,1968)$.

Eahiwanl $(11,2974)$ carried out a atudy involving three sethode of teaching programed instruotion (FI), integrated programed instruction (iFI), nad the conentional olanaroce apprench (COA). The major purpese of the study wae to find out whether boye' superiority in mathemetice at roporied by resourches from the west is troe with Konyan childrea.

The eubordiate purpose of the study was to inveatigate whothor attitude tovarde methematics, matheraticul reaconing, rocabulary of mathomation terme vocebulary of eciontific teme and computation are valld prediotors of ahievoment in mathomatice for Konya boys and girle.

354 form two atuciente from two boys' and two girle 'high schools in Hairobl constituted the sanplo for the study. Three clazses weinis ash of the four solected sohoole vere randomy aseignod to each of the follewiag trentmentas

[^3]- 40 -
progread Instruction, conventional ciassroom
approach and Intagrated pregremend Instructiono
At the beginaling of the experiment the
following premtarte ware adinistered to all the
mubjecte in the studyio
1. Ateltuce towarcs mathematles seelo.
2. Pive Dots - measuring mathematical
ebllstyo
3. Fraction - measuring ablilty to compute.
4. Asithmetic reasoning - meesuring
mathematical remoning ablilty.
5. Prababsilty pre-kast.
6. Comprohension of mathenatlcal vocabulary
test.
7. Compretension of selence vocabulary.
After the coninistration of the pro-tests
the subgects underwent on inetructional course
in probebility. The programed instructional
group learned through the progrem, odited by the
Investlgator, the comventional clasaroon approach
group bearnod thsough the teacherotalk method
while the integrated programed instruction
group learned through the progran supplemented
by the teacher.

The flyet and the necond achiovearat teste, dendgnod by the investigator wore administered to $a 11$ the subjecte in the study mali-wny through the instruction and at the and of the seasion which lasted two weeke. A rotention test was adniaistered to all tbe subjecta in the atudy alx wook alter the inatructions the studente were not inforeud of the impending retention teat. They had reverted to theis normal class routise arter the postmitest achovement.

The results of the promeste abov that boys in the PI and CCA Eroups seored higher than girle in attituie toward mathomatice, five dots. computetion (Fractions). Arththotic Reasoning, Comprobonsio of Mathematical and Eiciontific tern. while glrie perfozmod better on probability prontest. The III Eirle performod better than boys in all the prenteats except on comprehension of soloace terns.

The results of the achieverent teats reveal the following:

1. In the firut achovomont test, boys in the PI and IPI groupg had a hefor mand than girla, while gipla in the CCA group had a hegher man then boys of the seme group.
2. In the anoond achievarant tont. Eirla in the PI and III groupl purformed bettur than boge of the cane erous while boye in the COA gromp had a elightiy bettor monn than corle in the same group.

A t-test was used to teat for poseible dieforances betwoen boges and girie in the prontenta, pest-tent and retoation tout. Glsle 1n the PI and LPI groupe purformed better than boye in the san Eroups on the retention teat. Boya in the can group performed aigailicantly botter then girla of the sume group on the retention teat.

> When tetal aceres for boys and girla were amijsed, it was foumd that

1. Giric performed algailicantly better then boge ( $t=2.89 ;$ B $<0.05$; on the axythmotic seasonias toat.
2. Girle performed bettor than boge on the probability pro-test and on the secoad achievement test ( $t=4.09$; and 0.3 .23 seapectivolv, $8<0.05$ ).

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$$

3. There wore no signilichat difforeaces batweun boys and girle on attitude toward sathonsticn, sive dote, fractions (compritation), comprohosion of minthemation. and riionce tarna, firat achiovment teat ad retention test.

The roculte of the otopure regresaion analyale computed to determion the relationshis botwaen the pro-test variables and firet achiovemoat test vere ac followas-

1. Jor boys. five dots and axithmotic reacoulng were alenificant pradiotore of probability ahievemunt ( $p<0.05$ ).
2. Comprohmeica of mathematical terns, arithotic reasoaly and conputational abllity (Iractions) wore valid predictore of achiovement at the 0.05 levol of algmificance.

The atudy ruveale that eox difforences in Eathematice do exist anong Konyan high achool children. This sex difforences, however, camot bo attributed to the studente' attitudee tomude mathematics. If positive attitucie townrds tho subjeot were to go with highor sohlovement in
a mthematios tont, ther boge in this study would have scored mech bighor than the girle on the achiovement and an the retention test. If tho hpothoele that elria are better readore then boys is agythisg to go by, then one would expect eirls to do botter from progrens than boys. Eat this was not the caso in this atudre. Boge gained more frum the procren while efrle galnod no: from the bran teacher. The Luvestigetor did not comsider meading ability a one of the variablas, honce it is difflcult to eas whother boye wer better readore or giris.

It is not indicated in the study whothar the content targht to the COA Exoum covered the same information gromed as the progrin.

The resulte of the pro-teats fhow that girle were apemor to boye in pre-tegt probability. This is a clear indication that enbjocte were not initially comparable. Por the reason, the gromp should have been statistlcelly egated by the use of amizale of covariance.

Anothor solated etudy on programed learning In Africe ven cerried out by Parter ( 12,1974 ) 。

## 12

Pastrar, X. Dot The Ippact of the Procymen vortcoards on the imality of seaching Fathomatica 10 the secondary echools of Kany. Fi. Id. Thosis.1974.

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Tho pxapoce of tho otudy wae to find out whothor tharo wenld to -y Alfforoneo in cohiovomont
 whod and then temget iy procremund workeardo. Suboddlary juryeoo of the ettudy man to oxamine
 hov thee atticucon ehang darthe tho course of loaming and to ay-ito tholr attituro touncis the progren as a method of imotruction.

219 Torm 1 atcodonto from a boye' and a
girle: school in knirool comprimed tho subjocte for the etwl 7. Tho subjecto woro distributed
 control eromp adod tho other throe, the expertmontal
 (1.0. thore teo mo mocranimation of the clasees for tho perroonoc of the oxperimoti).

In ordor to contrel for cortain extrmone rectorm Ilso motivation, minco of imotruothon, toachang afte, lontilz of clacs pertod, timo of
 tocchor man costrand to tocch at loent oxoexperimartal oleos and oun control 01enc. Foth tho exporimontal het the control eroups leapned the sane materlal vith Bind lar rocabolary.
ayibolif and problcas. The investisator contanled that all errors would not be reaoved by the controla exarcised. Ho, hovever. oxpreased the bope that such orrory would be eliminated by the process of randonization.

Lt the beginaing of the atudy all the subjecte were administored batton's attitude scale. revised by the servesticmitor to suit the noods of his atudy. . The puryes of admiaistorige the attitude guestiomanire was to leare how Konjar high school studente folt about mathomatics. Three attitude scales vere ased for this purposes
2. attitude towards mathomatice as a proceme.
2. Attitude about difilcults of lemaning menematics.
3. Attitwie towards the place of mathonatics in cociaty.

Rellabillty data for thase scnles were not calculated. The san ciucstiomalie was adniniatered to all the rabjocts in the atudy at the ond of the yoar to ace if axy changes towarde mathonatice had bren made durine the course of the strudy.

The reanle of the pre-test attitude tovards mathomatice revenled no algoiricant differoncee

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$$

botwoen the experfinathl and control groaps (total) and botrocm boyn and girla in the atudy at the 0.05 lovel of aisulticance.

The roculte of the attituden sealo adruniatered at the and of the study wore as follomes

1. Thore wort no alenifiont differumeen between the expemmontal aroup and the control group is thalr attitude toward mathentics as a prooecs and in thoir attitede towneds the place of mathoantice is mooioty.
2. He alguiricant difforence botwoen the two sexes wat show for the thro ettitude scalos.
3. There was a algulificent dirferemce tounde the diriculty of iouraing mathenaice betweed the control boye ned control efrls (t - 2.25 B $P<0.05$ ) with the control boye having a higher mean attitude seore than the contril birle.

On attitude chaojes. the control boy chowed allght improvemonte in thelr attitude towarde matbentles during tho ecood tere compared to flent tern. Thare vore no algodifiosint differmoue
botween promtent and post-teat attitude townede mehemition.

Boge tended to favour the protrean more then the giris. Boye had a edenilicantly higher mean of 40.75 than the eirla' man of 35
( $七-2.298$ P $<0.05$ )
Achievemont tosta coveriag wat had been taught were given at the end of overy term. at the end of the therd tern, a 50 - maltiple choice Iten covering the material lesmod for the whole Jear mea adninimtered.

The resulte indicate that the experimontal Efirle perfored elealeficantly botter than the experimental boye in the ilirat, and acoond achleroment tests $(t=4.21$ and $t=5.048$ respectively $P(0.05$ ) while boje did better in the thind echicremont test ( $t=4.253, \mathrm{P}<0.05$ ). the control gixls porformed bettor in the flust achicroment tost ( $t=5.558 \mathrm{P}<0.05$ ) while the boye of tho sem inatructional growp did bettar in tho second and thind achiovoment tests ( $t=1.25$ and $=7.29$ respeotivelys $P<0.05$ ).

The results show that glele porformed alonificently botter in the firat achievoment
test while boys performance was aignificant in tho third acniuresant teat. Ihis would iodicate thut bojs bad a bicher rotentive power than eirls if the subjects were not informed at the end of the your that the final test would inciude work dons in the firgt and second Enme.

> Partar's study has proviciod a uãeful
information on the ceneral effoctivaness of the procran and te retontive offoct whan usud with Kenya's high achool chiliren.

Okmrotifa $(13,1968)$ conpanud programmed lorsming with tho conventional mathod of instruction.

The puriose of the atwis was threefolds

1. So find whether there would be any difference in attivete to pro ramad enterisle botween thow who learned by the program and those who learnod by conventional metbod of instruction.

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 Ehool ohil!ran to procraned instruction in Beography. Amontional Cegnassh Jomy al. Vol. 17. lio. 2. Feb. 1955, DP. 210-114.
2. No Ind thatbar the two iastructional groups exhsibitod any attitude disforences towarde geos riyity an asubjoct.
3. Io find wisch of the tro inotructional mothote under inveatigeticin vould be superior.

The subjacts for the atudy consisted of 200 second formers - 100 bore and 200 cirls. rundondy drawn from four schools representine urbum boye', urban girla' rursl boya' and sural Eirla' schoole in the llorth Central istate of Sigeria. The mono nge of the subjucte was 14 Jeare. Nome of the subjecte hed yrior exposure to prouramed saterials.

Before the study cominnoud the subjects wore ouldideterod a prowtent foogruphy achievenent. vorbol aptitode and zuunitarive appitule tosts.

After thenv tauta, all the subjecte in the study want throuch a ilowur prorm in civicu. The fautruction rent on for three besuluns. (3 days) the ond of the thind session the unbjecte wore divided into experimonial and conirol proups on the bais of their pre-test geofraphy achievemeat. verbul aptitude and funatitntive aptituce acoros.

The nubjecta wore than admindatered a
pro-tect attitude towards geography and a prenteet attitnde toverds the progre
(INrart - Eype).

Nther the adafintrution of the pre-tents tho auljecte modermut in inetructican conres in tap readiag in gootraplor. inso experimantal geroup loarend throuch the prograng wille the control froup leawnd from tho compertional texts. The experimental grow was presented wth Iive geocrephy programed texte and the convantional group with live comentional tozts in Eoosraphy. the conventional texte coverud the eamo upar of information as the profrome. An americen mod reuding procren, with a vereion adapten to Hiseria goographical conditions man resed in tho studr.

2ue imvectigator boped to control for posutblo mothodological errore by mitime tho studente mare that they wers invoived in an experiment concermed uith theis loarning in goouraphy and by vuming thom againet ans Iertage as it mas thon th that loatego would destroy the apporinontal tost of the indopendent variables.

The subjects were not mare that they vere
divided into two different treatment groups. The investigator hoped that the "Rosenthal Effect" would cancel out since both the instructors and students were not awere of his hypotheses to be tested. He further hoped that by employing instructors who were not normal teachers in the experimental schools and by testing all the subjects in the study, he would level out the "Hawthorne Effect."

After the instruction, a post-test achievement and a post-test attitude towards geography and the program were administered to all the subjects. in the study.

The results of the pre-tests showed no significant differences in verbal aptitude, quantitative aptitude, pre-test geography. . achievement and age. Where were significant differences in pre-test geography attitude and pre-test program attitude, the control group showing more positive attitude in both cases. The significant differences in the pre-tests indicated a need for statistically equating the two groups.

A threcmay emijsio of corariance wes
computed to compare soography achieverent. attitude towarde matbeation and attitude tovard the procrin. Teaohing mothodn, sex and school environnent more used as the main effects while prontent ecores wore used as covariate and pont-teat acores an aritorion. An Faratio of 23.56 showed that there ware significant differences in temohing mothode ( $P<0.01$ ), the prograned erroup perforning bottor than tho contsol group. Fio significant differences vore Sound anong other veriancos. The eroupa' learnins times ccorve were compared by a zeen factorial analysis of varimee. there wore no sientificant min erfocte for mothodig. sox and sohool amiromont. Melthor wore there any algoificant interactions involving sex, methede and sehoal enviroment varimbles. On the basia of these remilta, it was conciuded that programed inutruotion mas more oflicicat than the conventionn inatruction in contributine to pupile achiovenent.
$42 \times 32$ maljais of covariance computod to conpare the aubjects' attitude towarde map
reading revocled shinificant difforencon in mothod variances ( $1=16.19$; $P<0.01$ ). The prograniod inatruction eroup ahowod a more altnificant favourable attitude towands map reading than the coaventional toxt aroup. The other varimboes wore not alguificunt. The author attributed the sore invourablo attitede aboum by the expemmental group to two factores
2. The procrean wore well validateds
2. Progreined instruction unaliy enphanizos inmodiate conflnention of remalte, ective response, constant evaluation appropriate practice and graduated sequence.

The authar contencle that these two feotors Might have mado anp reading eanier and more satiaffing and therefore more liked by the programed group.
$42030^{2}$ anigate of covariance was aleo compated to compare the aubjucta' attitude tomarde the prorym. Mothode ( $1=43.12 ; P<01)$ and -ax ( 1 - 3.991 $\mathrm{E}<0$ 05) varlancen were found to be sigalificame. The progrnman group had anere Lavoarable attitude tewarde the prefran than the coaventional text groum. Boye wore fomad

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to to no50 incllwod to progremed inotruction ther Eirla. Instially, tho control exoup eodubited a more poaitive attitude towards the grogin than tho experimontal grorpe Lrtor inotraction, the trend changed, the experimontal Geore now ohoulne a more poaitive attitude than the control sFoup. the author sugconts the Feanom for this to be the leagth of time both groupe wose in contract with the proctan. The contral group wore in contact with the procrmo for only throe sassions at the beginaing of the study while the expurimontril erow ware in throughout contact with the jrogrmin the loarning aeualon

4 complation of $\pm=0.242$ betwoen peato test geosrmint achiovement and postoteat atthtode torards the prograns in the experimantal שroup engranta that a poustive attitude towards the progrea doan not mocosearily rosult in hist cohforomant.

The results of this study have confireed son of the emrlier researehos rovieuct in the thesis thit lenmiag in groater from programed Enterdale than frow tho convontional meterlale ocvoring the game span of information an the progran. 4 .he finding that boye tond to liko
the progren more than the Eiris indicate that boje like to shor more independence in thois worl than the rixia wio like tho axppertive role of the tenchar. This frot is consirnod by Eehivani'n atudy ( 11,1974 ) whiah roported that boga learnod noxe through the progrema while girle gained more fron the man temober. Asother comparative atudy iavolving progrand and conrantiomi inatruotion in Africa wan earried out by Bonbuak (14,1968).
the leveatigation way done with fourtb-joar atudente in a secondary gramer sehool in yest Mrevin. The proctimad and the conventional groupe wore stated to be of equal ability in phyalcs. The groupe ware axrangod on the basia of their end-of-yers axalination taken in jucember. 1967.

A prontant (Kinder-älohandion rellabilitys 0.58) mac adriniatered to both eroupa on Fob. 2, 1968. 2th 27 - Item objuctive test

## 12

Op. aft.
14
 between convontionl and procirind imetructiono. Progranmed Lamzing and Pincational Technolory, V1. 7.2970
containad prerrequiaito and pro-knowludge itens.

Betwecin Job. 2 and $\mathrm{Feb} .19,2968$ both Exoupa nodervent in inetrectional course on mase. wolght and density during nornal lescons. Care was tatas not to dicurpt the uliabor arancononte for tho tere. The proyrumed group wertad tbromgh a progriond tort oupylasunted by the standard ehool prectical experimonte aupervised bo tho tenches while the conventional ifxoup followod the morenl rehool syallabo but carriod cut the cen atosiand oxporimonts an the progrenod ingtreotion groupo

It the and of the inatrection, an Pob. 29. 2968. 19 - 1ten pesteteat (Knder-ISchardoce rollabllitys 0.85) was admiadetered to both eroupe in the study. Ho retantion tent wan comintetered duo to what the writer oalle "political an adalafatrative difsionletes." Thu secte adminiaterod wore bencd on tho content of the progren and on those eappliod by the writer of the progren.
$\Delta$ thont was usod to capars the meane for the two हroupe in the proetent and portwtent achievement.

The results show that the non-programed froup perforwod elpmificantly botter than the

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progrinind gerup in the prontent mohioverant ( $t=2.954$; I .01) . In the pontentest, the progirinod sroup showod sapperios perfarnaroe to the comventionn grovi (t $=2.6358 \mathrm{P} / 005$ ).

On the banis of the inftial differencos shour in the proptect anizeln. tho anthor deokded to equate the proups by esing an analysia of covariapoc. This analjela Inroaled that thers ma algrificant difforenco botweon the segression coerflelente ( $F$ - 32.67: PL.001). decording to tho author, this afoulicanoe show that the pro-teat/poct-test relationship for the two froupe was not of the sam fory. The two frompe have learned different erpecte of the mbject metes.
the author concluden that tbough the procremed Gronp chowed mperiortty ovor the comentioma group. the results show that the two mothode enphesiect dfrforent concopts and hence the observad differoncen in attelsmont wore a function of the teating procedures used.

Studien on progremed loumsing have not boen linited to comperisons batwoen prorjramod instruction and conventionn instruction. Som
etudion have arminad the effact of the proctian on retention. Dick $(15,1965)$ compered the Imodiate delajed perforance of atudente who worted in paire with the performence of students tho vorted alone.

The major pmopese of tho study vas to dotoraine if the palred uov of programed matoriale, waich iavolvod verbal intoraction betwees two studente resulted in superior retention when compared to a group of atudente who worked aloce.

The aubjoete wore atudente who enrolled in mathenatice at the Penagyrania state Unirorsity In the Wiater Forn, 2962. The subjecte wore randonly analgrod to two eroups, one groum comsisting of studente who worteod in paire and the other froup, comiating of atodents who marked alome. Both eroups were tented far verbul and guantitative ability with the achool and college Abilsty Tost (8CLT). The palred Exoup hand the progre placod botwoon two studonts. The atudents

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DLak, lios Individual use of programed ingtruations the Mathetion genchere Vol. 58, 10. 7. 1965. pp. 519 - 654.
dsecusaed the matering in the proerin uith when thoy had diflemity.

Daily tosis. sid-ter teate and fimal canatration wero administered. su amizeis of covariano uning total 3 CAA wores an the control Variable showed no slgniflcant difforence botroen the two Eroupa on their total daily teat points. ridtern and Iinal crainations, or tho tost of tranufor. Ro aigaifleant ilffarance was sbom in the subjects" attitude torard the course in eeneral or townerd the prograt.

One jear lator. during the latter mela of the Minter sern. 1953. $80 \%$ of the etudonts wer retested. thenalyalo of eovaslance vais used to test for tho elguiflanow of the difference in retantion of pairad and ioulvidun groups. The postrtest scores were ueod as the contral variabl. while the retention tent scores an the criterion. The reanite show a dgnisicant disfurence $(5=3.7730 .05 \angle P<0.07)$ in fevons of the paired proxpe.

Whon ability monmur (BCas) and pont-tast sooren waro corrolated with the rotention tegt to detervine which variabla uns a botter
predsctar of sotention, it we fourd that the postmeert ceorven wes alcoiriantiJ better predictor of rutcatione reo corralation betroca the Izan cramgntion and tho retention teet vas $5=0.89$ lor the palred grompe The correlation botweca total 8CAT and the retention teat soores was $\mathrm{r}=0.43$ for the sam group. the differemce between tho correlation man Significent $(t=4.95 ; 2 \angle 0.01)$. For tho individunl treatment croup the correletions were $5=0.77$ botwaen the final exmination and retontion tost, and $E=0.50$, botwuen $4 C A$ seores and retention tent scores. the diffurence between thee correlations mas aleo elgnificent (t - 2.96i $8 / 0.06$ ).

2hew regults of this atoudy led tho inveatigetor to conclede that the bencllts of peired learning aro found in the rotontion of the material and not in the irmodinte poriormace of the memern. The correlation botween the final comination and retoation tost for both Eroups sbow that tho beet prodictor of rotontion is the poat-test achiovenont and not a fonorml iosilty moneure.

Though the sesouraheo revieved hure heve confletims meaults zegmading the experierity
of the proerre ovor tho comventional mothod, tho genorul Fiew corvojed is that the probrun tenahar botter than tho conventional method and that the proger encourages the atulents to bo more, indepondent in tboir wort.

The arperiarity of the profxan orar the conventional mode of inntruotion van reported by Murdoh ( 6,2968 ). Banghart, et al (7, 1963). Parter (12, 1974), Ormerotile (13, 1968) and Koobeck ( 14,2968 ).

Behiwarl (11, 2974) found the prozare to be more elfuctive wth boye bet firle ifed thencolvee more at hom whan they lease throurb the mina teacher. Although तु0luberg (10, 1966) form no nicnificant differmoo in arithmetic achlopenoent, his exporimontal kroup, i.e.e the prove that learnod throunth the proyreme shoucd nore indepandenco in thols wort. Iupile" genomil opieion wes that ther learpod more from meterinle than from conventional mesifale. Dick's study (15. 1955) reparte no difformee when the performen of childrea who learmed by the procren in patre was ocmpared with the performance of childina tho learnod individually also by the procsum whos moacund by a peot-ntest achiovemont.

Bat whon a delarad post-test achiovament vas given, the palred group retelosd nore neterkal thes the group worting individunl2y. This above that the progran is nore usesul for the stodonts learning in palre than for those loamise indifiduaily.

Mesdoveroft's ELindinge (9, 1965) are
somoritat contrary to the findings of researchas revions bore. Ho fornd no sisnificant differences betwond the procramea instruction errous and the cosventional instructional group whon total scores were conaldered. Bet when scores for difforeat abllity grourge were conshinereh. aferificant difforances were found between the acculerated soctions, with the acelerwted acetion of the control erour perforning better than the anco suction in the experimuntal group. Roadoweroft pet formand 080 meorul point that should be conaidered anrofully by future reseacehore, manely that the auccess of ang prograt rumaine with the deaige of the matoriale and equipment and the ntilisation of the inntructional devioes. Senght'r (7. 1963) augeestion reinforces this View. Banghart megreate that for and progrin to be mestul, it must bo used in combrention with
the tenoher. the tenchore involved with the progren met ahow conpetonce in handing the progren and thos mat alco show interent in the proste.

Jariesan's studs $(8,1969)$ considered suoh Vaclables lite methemtical ability and ECe. IO found that it io matbomatical abilsty and not ege that afloct echfovonant. The study furthos rovenled thut alder poople are just as enthmalatse to new materials an the joonger 0303.

Tho finisince fron the resoarabea sevievod in thin chapter huro guided tho imsoetigater of tho preseat atedj to plan hio wort. Epecifically. ibe preant etudy has been planned and dexpeod alos the limes of some of the resoarobes 00 fer reviowad.

## CINPRER 2RTRLE

## 

### 3.0 Itraonucerion

This ohaptor reporte the proceduse and deaige of the preseat atudy. the chapter begins by describing the conntruction of the learning materials and manuring instruentr, thon moves an to desarelbe the conduct of the pilot atudy. Pionallo, the chapter drele at loagth on the main atudy.

##  

Whe Exocren

In Japeney 1977, the inventigator of thic atudy eat out to mpite a progree which would constitute the learning materials for the rubjecte in his main atudy. The wating and the try-out of the programed materials veat on aimultanoualy.

The Loventifator socured pernianion from tho Bondmeter of Meirobl Primary Sehool to tent hie progened materiale with the pupile of


#### Abstract

gtandicd aix. The pturpose of the tyy-out mas to eanble the yriter to reconstruct the freme $s 0$ as to emble the pupils to 80 through the procgre with minim difficulty.


The subjocts far the tyy-out consinted of all the pupiln in the three struen in class oix in Balrobl phinaxy school. The hoadraster folt that setefing une of only onc cless would put that clase at an adrantage over the other clanses when they cone to do the toyic now meler inventismetion (probability). The imvestigator was granted three Lessons a weok of 35 minutes each in each class.

2te tople chosen for investigation was to be leasmod durlag tho thly term acoording to the gillabe arrayements. 2he materlal was prosonted to tho onsldion by manas of an overhead projector which was borrowed fran the Resouree Gection of the Faculty of Education, Fiscobl Univaraity.

Fach pu;il read each Iran projected on one of the welle of the elassrock. Frpils wrote dow their responses to the question in each frate on pleces of peper mupplied by the inveatigator. At the end of each leseon the

## - 67 .

Investigator collected the papers for marking. The cremes 20 far presented to the pupils were then revised on the basis of the pupils' responeen. If - free was correctly responded to by eos or more of all the pupils, such a from was thought to be good and was therefore not sevicod. The revise frames wert again presented to the pupils ane again revises on the bests of their rasponsen to the frames. The process contimed for a period of one month. By the end of the fourth weak, all the 175 frames had been revised at least three times. The revised frame ware then typed and stapled into small booklets. with answers given at the back of each page. Three booklet e comprised the thole progre. The first booklet was on Ideas about chance events. Here are two examples.

Example 00
3. Sow things are more likely to happen then others.
(a) Which 18 more lIkely. that one of the pupils In this class will be consent or that the mathematics teacher in this class will be absent? $\qquad$
(b) Which is more 115017, that you will hare neal for breakfast or that you w ll hive ural for lunch?
(Ugali is a stiff porridge made of maize, millet or cassava flour)
Exrumle 01
16. Iou are to play a gina with jour friend. Ito gem is mean a die one o and neo tho mime" (The die is cubic)
In this gam you via 112 dhow up. Tho
other player wine if 3 shows mp. In order to decide whether the gem is fair or viral
we first list all the possible outcomes


The second book t we o about itgperimeatr in Probability. An example follows.

## Example $0 ?$

43. Burma tossed a die 20 times and recorded her outcome in the Rollouling tablas


You now toss a die 60 ties and make a record of the number of dote an the top face. Record your results is a trouble such as the one show above.
44. Dee the results of frame 43 to answer the following guostiones-
(a) How many 1's did you got? $^{\prime}$ $\qquad$
(b) How many $3^{\circ} \mathrm{m}$ did you got? $\qquad$
(c) Did you got each outcome about the same number of times?

The o third booklet was on "Finding rrobebilitice." Hare is ex examples-

## Exaswla 03

108. Than tossing on die, we have air outcomes. Ho waite the 6 under the bar of a fractions

$$
\overline{6}
$$

Getting the outcome 3 is jail as likely at any of the others. 50 expect it about $\frac{1}{6}$ of the tin. Wo say, "tho probability of 3 10 w wite $p(3)=$ $\qquad$
The investigator found it expedient to divide the propmen into the three section bocasse be believes that prepils abound first involve themselves with experiments before they owes to
flad probablistios of croats. It was hoped that the flret and the secord section of tho program would enible the pupils to distinguinh botweon the expected and experimantal ortoomon. Arter tho payils hure fanillarised themocivea with the two sections, they vould then bo ablo to lind the probability of events by cuplojing som abstrect reasoning.

The progren was conirnoted by the inventio gator frow the following bootes-

1. Eonye Prinaxy Mathenatice Boat 6 (Lupil's and Soacheris Boake).
2. Komer Primary llatbemation Book 7 (Hapilis and Penchar' (300\%s).
3. Eeconday Gobool Matheratios (Spocial Idition, Student's reat and Temchor'a Comentery) by the Jobool Ratheration study Group.

During the try-out of the progree, the puplle mere not asposed to the anowarn to the frmen. Do there wan no imeediato oonsirmation of results. Tho amwere to tho frames woso sead ort to the paplis by the investigetor after he had marted thoir acripts.

At the and of the try-out, a 20-iten
achioroment teat and a 5 - iten attitudo
grestionaly temerds the procrim wore adnintatered to all the subjecte in the
tryont atudy. Item analyses for these tests were not carried out)
the purpece of adalaiatering the aohlerment tert was to fisd out whother the progrim, now bolieved to be in ite finel fork could toach. The mean performance of the pagile vas B.5, with e etundand doviation of 3.3. marke. (The teat wan maxted out of 20).

The attitude towarde the progrean questionadre man edminiatered to find ont whether the pepill liked the program or not. It wan olear rion the proils livoly bohaviour is the clase that they vere highly entrualentic to precremad matoriale. Geo itom saguired whether pupila mould like to noe procrimad materials evosyday. ro\% of the prapile sald that thoy vould like to use proproned matoriale everytay and $20 \%$ said thoy would not vhile $20 \%$ were not sare. $75 \%$ of the papile poaitively reaponded to an itoz which regulired thom to state whothor thoy preforred procremed inetraction to thoir unual mode of inutruction. The poitive reaponse indicated that thay preforred the proyre to the mode of
inotznction to which they had boen acomstoned. In geaoral. the pupils of the try-out study expreced favourable attitude to programed materials.

81noc the progren vas triednoent with pupile of a high cont mehool in Introbl (the hist cost sohool papils are gemorally ascuned to be aporiar in acudenic performance to tho suplis Isom lownost achoole), and since the satual etudy was to be condveted in Esaum with propils froe lowncost echools, the invectigator thourt It IIttiog to trymont the "Infishoe" progran with a somple of papils from a low-ooet primary school in Iicuri Town. One single-atreened school was randont acloctod from all Eincionstreanod echools in kieu fore. In this cchool. all tho 50 mtandard afr pripile verv enbjocted to the tyy-eut atudje The study we oobductod in mid Fobreary, 2977. the 11mear prosren wort handed to the proile seotiun by auction. whey weat throngh Che progren individually abd at thoir onn pace. When a puril comyleted a booklet be colleoted anothor one from the investigator. the investigator allourd tho prpils to tate tho procrian home so that tho etud could be completed in the sbortest tima
possible. This wee done under the acountion that the pupile would contime to read the progrean at home.

Asware to each frame wore provided at the back of each pase. At the end of each eeotion. there was a solf-teat with anmere following the tent. The pupile wore reguired to do the test, thes confin their respomes from the angwore. The major differome in learmang betwoea the try-cut subjecte in Zianse and tho try-out anbjocte in Malrobl is that the try-oect subjecta in Kinum vore prowided with imodiate conflyation of reanlte. stals is to any that the progrem, now conaldered to be is its final 808 hand anewore to the irmes at the baok of each page.

At the and of the thind wook of tastrection, the rubjocte wore adninistored a teat as probebility ainilar to the one administered to the pupile in the trymort atudy in lairobi Primiry Bebool. The moan and tho etandard doviation for the scores for 50 phiple were computed. the moan vas found to bo 7.6 with a atander doviation of 3.5 marice. The reaults

Mere were L ound to be sominow conpurable to the resulte of the eubjocte in Mairobl (man 8.5, standand deviation 3.3). The investigator was then of the opinion that the progrmin conld teach, and did not therefore require axy furtber rovision. He them set out to conduct a pilot studf.

## 3.1 .2 깨․ 工, … 6

The lessons nsed by the contcol group mox canervetod frem tho procimen. This van to ensure that the contont covered in tho Lessons was cemprable in atylo and disifcolty to the contont coversed in tho progran. Wise the progren. tho lesecn yas aleo divided into three sectiong: section on containod varion "Ideas about chance. eaction two was ebout "packnants in Probalility and tho third asetion dealt with "Piadine Probabilitiono"

### 3.200 comaincmiul OF MF Ning

Before the pilot atudy comenced, pro-test acjivverant and postntent achievoucat to bo med in the min atudy wre constructed. The tests vare constrwoted from the progranmed and the
-75 -
lesson notes. 5hla was to enaure that the iten In tho teat did not favour ens ono instructional nothod.

## 3.2 .1 RROMTOF aCIT T.H:TX

This consisted of 25 multiplemonoice items dostrad to noamre the pupile' initial knowledse of probability. The tont eampled the information to be covered in tho propran and in the lesson. thase question were a roviacd verelun of the guoction arighaliz adminintered to tho try-cest cubjecte. 4 fimal roviaion of item yas don in th pllot studs boior adminfetration Is the main stodr. 8ono of the itcen vere of a copral mintur. destenod to moacure a child'a abulty to reacon intuitivelyo

The tten were ontegorized ncconding to BLoan's Spoclrication (16, 1972). 3100n's categorles of cognitive lovelo into which the sten wose divided include knouledge of pecirke Lacts, comprehonaion, applicution and analyais. the ubjects in the atudy vere not avare of

16
3100n. B.8., ot als Handbook of formative and concive cralnation of student learninge. Hegrea - M111 Bool Coop 1971. pp. 272-273.
thle specification.
iftor oareful soreoning of the probtest, only throe itom rominod to trost childrea's knowledere of specific facts. is it has boen stated cerlier in this section krowledje items ware mather genoril, mainly denignod to test a child's intultive reasoning. Erampien of knowledge. conprabasion. application and analysie iteme follen balowt-

Kannle 003 (Knowledes)

Think of apinning the pointer of the apinas an the right. The polnter is likely to stop on red
(a) X of the time.
(b) $1 / 3$ of the time
(c) 0 of the timo
(d) 112 of the timo.

Bemmin Con (Comprohension)


Atcke apian the polater of apianer 100 time and gots $25 \mathrm{red}, 25 \mathrm{blve}$, and 50 yollow.
thich of tho following atatements ie trwe?
(a) The dind of the apinnor is $x$ jolloc.
(b) the dial of the epimer ia $\frac{1}{3}$ green.

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(c) The dial of the splnmer in tolue. (d) The dial of the spinmer 2 e 512 sed.


## Exangis ogs (Appllcatlen)

the cable below shove all the peselble outcomed then two coln are kosicd.


What is the probeblilty of getting a heed and e tas
(a) 1
(b) 8
(c) $\frac{1}{3}$
(1) 2.

Exegel $00 \%$ (Amalysis)
Temá Deg contain three masbles, ono red. one wilte and one blue. If tab chooset one mestle vithost locilm. net is the probablilty that the masble Tate cheoses is redz
(a) $\frac{3}{3}$ (b) 2 (c) $\frac{1}{3} \quad$ (a) 0

## 

Thie consifted of 20 objective type itean covering the progren and the lesmon. Ithe itom in this tout ware 100 categorised accordin; to 3loce's epecilication (16, 1971). intamplos of auch iten ere given below.

Example 0,02 (moriodet)

1) If man ovent in cortain to occur. ito probabllity 1 es
(a) 0
(b) $\%$
(ब) 2
(d) Groater than 10

Brannle 00. (Comprotension)
5) Th wrobabillty of throwing exactly foer hade and one tall in = to in $\frac{5}{32}$. What is the provibility of nots throwing four hoade and ono tall?
(a) $\frac{5}{32}$
(b) 2
(c) $\frac{22}{32}$
(d) 0

Feapple 009 (Applicution)
11) In a gembling geno whore one coin is to bo tomsed a ployer wine if be scores two beadsand ano tail. How many timos must ho tose the cosin?
(a) 8 timos
(b) ence
(c) three time
(d) tuce.

Example 010 (amajais)
10) Two dice are tossed tociothor. What is the probublilty of zoting a ar of 6 ox a mam of 7 ?
(a) $\frac{1}{6}$
(b) $\frac{1}{3}$
(a) $\frac{11}{36}$
(d) $\frac{5}{36}$


The aplmer above is divictod iuto eire oqual reglone. Use it to lise the probability of alther bod or 2.
(a) $\frac{2}{3}$
(b) $\frac{1}{6}$
(c) $\frac{1}{3}$
(d) $1 / 2$

Whe the prentent itens, the postotent itcers receivod onroinl corutimy boing mevised tuice before the investication.

The item wors arranged in the following ordore iten ose to four mere mowledse items, Ltem 5 to 8 wore comprohnaifon itenas miser 9 to 15 were application ltom and 1 teme peibar 26 to 20 couprised anatyoin itcun. The pupils var dot amax of guch an arzagamuet.

### 3.2.3. DFECHUPTIOY OF THE COGMTTVE IETEIS

As han beon mantionod in section 3.2 .1 and 3.2.2. the prowtost and pestotent werv antegorised acoording to Blone's Tuxonanons of Educstional objeotiven into fors menfor cognitivo ievele. Thow axel lnowledge of apeciflo facte. comprehonsion applic:ition and analyin. Blocm Lncludee two other lovela, manely apathosis and evalemtion. shese two levula wore considered to be beyond the lovel of papila moder luvestigatione The study, thorefore, vas linited to the flrmt four levels of coraition A dosoription of onoh of thed four levele follous belou.

## Knowledge of 3pectifte. Racta

Sloon defimes knowledge es recall of spectifles ant unfversala, the recall of metheds and processes, or the recall of a pattern, strveture or eatting. In this lovel the pupil wes required to recell the naterlal learned earlier. For exmple, if he is able to recall that if en event is certain to occur, then its prebeisilty is i, then we hee disployed his know leoge of that fnet. This fact will be remenbered from the sect that $0 \leq 1 \leq 1$.

## Cesorehenston

Thin reprenents the lowet level of understandin. Here. an individual is supposed to kmow what is beling comminicated and should be cble to acke use of the materlal or ldee belng conmunicated without mocessarliy rolating it to other materlal or sealng fies fullest implication. An excmple of an item incluced in thls category has been given in exmple o0b. Here the enild was told that the probablility of obtaining exectly four heacs and one tall in a tose of five colns was $\frac{5}{32^{\circ}}$, Ho wae then asked to state the probesility of not obtaining four heads anc one taliz This iten required the
child to boow that tho probability of a sume thing in 1 and then we this knouledse to find the complenant of obtrining forr hoada and ane tall.

## Apoliancion

In this ievel tho child in required to ayply the Eatarial Iready learwed and comrobenced to now altuatione. Applicution ie defined by Bloon an the of mberraction in partloulas and concrete alcuationse the mbetrnction may be for gevernl ldeas, rules of procedures. fonorilled mothed, teobnical prinoipien and thoories. thaeo should bo rembered and applicd in now sitrations.

## Ans17nis

In this level a pupil in moguired to brouts - eivee proble into 1 te constiseont parte 00 that bo ale:arly raderatande the relations betwece ldea expreased. ano axriple of thin $20 v e l$ io giren in arenple 010, sten mo. 28. In thie example the child is told that two dice aro toased. H0 is then acted to find the probablisty of gotting eitbar a ar of 6 or a on of 7 . the child is regulen to break dow the information a follomes
(a) Ho crams up a table.
(b) Bo lints the outcome when on dice is tossed, on the tog of the table.
(c) Bo Lats the onteones when the second alice is tossed, an the loft of the table.
(d) He than wilton down the elements in an cedesed pair in each cell of the table when the two dice are tossed together.
(a) Pimaily, be adds up each of the ordered pain to see which ordered pair gives hin a eu e of 6 or a cum of 7. STol a table is given below.


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From the table the child will soc that IVve oamer will give hin a sul of 6 and 6 palse will give him a of 7. The total le 11. Hence the probablitity of obtaining a an of 6 or a ou of 7 uben two dice ere tomsed is 23. 2then bofore the ohild ilanily sotiles 36 to man anver of $\frac{31}{36}$, be would have reasased through six stage:. The sixth atage involven courting the miber of coils to got the anmple apace.
3.204 REGDTHG ABITIMR

Ono of the rariables componis inventicated in a prokramed leurning experinat is childrea's reading ability. Oeo cuention often malked les "Do good readere alvaye perform better in en achleveaent teat than poor rendera?" In order to anowes this question a 17-1ten rending ability test was givea to the prepile in the study. The test was construoted by J. I. Sahonsoll. It mas adriniatored to tho subjects without ary reviaion made as an amiyaile of the pllot atudy revealod that the tent had a high mollability cooficient of $\mathrm{F}=0.89$ 。

In this toat children ware required to rend ahort sentences ailently then reapond to a
quastion at the and of tho santence.

## 

An everage of three tests. nuedro Dlagnontle Iest in Pricer J̌znotions, Arithmotic Feaconity and woricins with themore conotituted the anthenution ability moumure. The

3Lagnontio rest in Fulgar lxactions wan a 24 - 1ton Rest cangtructed by J. I. Schomen. The rearining two teate, Askthontic Reagoning and working with Honbers, eah complaing 10 Item vere obtaimad frow the mupervisor.
 for these three teuts were en followso Trectione (K20 0.93)s Arethmotic zownoning ( $x_{\frac{1}{2} \frac{1}{2}}=0$.en) and Hartsing with Themern ( $x_{\frac{1}{2} \frac{1}{2}}=0.55$ ). ( $x \frac{1}{2} \frac{1}{2}=$ split-half reliability coefficient) 302.600 LIALEUDE USTLURGURS

Swo attitude gquatiomalrea wore aministered to the enhtoots in the man etudy. Twese ware perpils' attitude townris methmention and pup118" attitude towarde the progrel. stese two scales ver obtained from the apmerieer Dr. G. B. Behfueni. The major parpone for adrindetering tho two attlitude scales wae to se0 whother a puy11"s attitude towards a subject or towarde the method
by wish that aubjret is dearned is a good predictor of achievement in the criterion teat.


The quentiorenle conpised 22 iteme. This wan a fow-point Likart-type attitude sonle rangiag from iticergy howe to Stromishy Disagase. the acalos uned to cuantioy the itemo worv utrongly arren. agren, disegreo and atrancly dinacreo. the prepils were asked to toll how they felt ubout anch statenent by clicling one of the categories. The categories wore reapectivoly eiven differential soores of $+2,+1$, -1, -2 for stronghy agree, egrex, diangroe and atrongly dicagres. Tre attitudes expseseod if the subjocte were soored in the uno directica, with ecrecmat uith a positive atatemant sooring the som en dicagrecmont nith a magive statement.

41 the throe inatructional eroups wero adrindetered thle attitude quostionnelve. The attitude laventary was not extonded to tenchers as It ven thought that the teachors involved is the atudy were too fow to give a reprosentative opintion of all tomohors. However, the teachins
asuistenter exprossed vory usorvil ideas.

## 

$$
\text { This was a } 22 \text { - Itce Idsart - type attitude }
$$

coule. Five catogorion vere used to quatify the ittem. These vore atronely agree. agree. undeoldod, dieagrien, and strongly disagree. ano categorice wert gives ncores of $+2,4,0,-1$, and 2. rospeotively. ith prinis ware ackod to ladicate the atrongth of thole preforencen by ciraling one of the categories. It mas asennod that the pupils ${ }^{\circ}$ choices would ropresent a treo picture of thole opiaione

The itens containod alx poaitive and aix pegative iten randoaly mod within the test. is in the attitudo towarde Enthonation quostionalre. the attituce tovards the progrea were soored in the ane directicn, with agrecment with a ponitive etatoment scoring the semo as diegoremont with a nogative atatcment.

## 

Twe axperimatal matertale consisted of glaco marbles, dice, apinnere of variun sidec and coim.

Dice vare mado out of a 2 in . 21 in . $x /$ 1an. pioces of wood by the inventigator at the Konga Iaritute of Eduoation workehope tho facea of the cubes wozt marked in ench a way that the sua of tho oppoaite faces vas 7. Gluse marblos ware bought fron the ahope. Ithe teachers were anked to cometrict aplumere with thols elasses and have then ready bofore the atart of the experimonts. kach pupll involvod in the atudy was asked to provide Minulf with a 5-cont. a 20 - cont and a 50 - cont coln

412 tbose experimoatal matemule vere ready before the mals atudy conneaced. The investigator provided 21 the materiale nouded for the pilot study eave the coim moloh ware provided by overy ohild iavolved is the pilce study.

## 

at the olose of the trymourt study, in the socond weck of fiareh whea all the monguring instrumate and learaing tacke hed boon construotel, the idevestigator set to conduct a pilot atude.

3ohal PURPOSE OF TEE PILOT STUDY
The perpowe of the pillot atudy val twofolds-
2. To find out whither the revicod progria could be auccesarul is teaching, asd
2. Wo fiod out tho aritability of the teste to be administered in the mia study.


One singleratrened sobool was randonis selected from all unclentreined schoole in上icuin Forme the sohool seleoted was ene of the lov-eont primary schoule not lavolved is the try-out atudy. All the stamdard adx payils is the selceted sahool oonntituted the subjecta for the pilot atudy.

Aftar the pilot study school had beas solected all the atandard aix proils in the school wore adninintered the following teatas
2. 4 15-itea probability pre-teat dealgned to meanure the punily suttial knoviedse of probability. the pro-tent wan a roviced form of the test adninistered to the try-out cobjoota.
2. A tost an childrane rendiac, whility takem frow J. F. Sohomonl'y "piagnoztic and

- 90 -

Attaisunt Rosting sont $\mathrm{A}_{\mathrm{g}}$
3. A test of childras's sunoral methenetical
 Irmethan and vortclat with ranbars.
4. A pontmeat mohievemant. Tus sect was edninintered to 011 the proiln present insodiately after instraction.

To rotcrition test and attitude questionnalse man adrinistesed to the pilet atudy krote.


Aftor the adninietration of the prenteats. - conres of inntruction in probability. mperviaced th the inventigetor wa given to all the priplle In the cies. the lonuratig tan conmisted of a 175 - fren limoar progron proucated in threo scotions. As moted is mection 3.1.0, enetion on of the progin wen about "Ithinidin" abont chance." the puryose of the coction va to atiulato puys to thinls mari ebjectivelv noout chance ovente. Purils would have an opporturity to toat thols intuition throng participation and dimenseiono This seation was expposed to ancourege ensidren to make gresses. estimates and prodictions aboet chenee evente.

Eeetion two cealt whth "Experinoate in Frobebility." Thie acotion wae dealgnod to belp pupils alarify their concepts of chanoe and uncertainty. 的 performing axperimants with dice, Earblea, apinnore and colse, and tabolating thels reculta, pupile ware auppeed to diecover posable patteres mang chence ovents and to ree these pattorns to eatimute suture outcomes. An entimation of future cutcomen rould casble the pupila to dintingutin betwoen axperimental and expeoted occurunces.

Fren 99 of section two requisen chilurea to interprot a bar chart. rude is to reinforeo thair idean relating to probability.

Pinally, when the claildrua come to bection three of the profgen, an arcuaption is made that they have gethored enough data srom thais metivitien in acotions ane and twe and oan summerise thom data in tnbles. In aection three, propile are supposed to ueo the idens ghinod srom the provices two sections to calculate the probablisties of evente. Bere, they are introdnced to the ute of rational mabers an a monare of probability. At thl atage of learnimg probablitity chsidren ase ascumed to be capablo of abotract thinking.
3.4.5. PHOCLIDURE

A limare progran was handed section by section to rech pupil in the clase. A pupil could discuce tho contoate of the progran with a fricad if moed be. Pupils were allowed to take the pregran boae. Probleng ancountered by the pupile whan going through the progrer were explaiad by the iavestigator. The geestions acked by the pupils were gemorally concerned with language problems. The pupile were informed that they wore involvod in an experinont.

Pive periods a veek was allocated for this exerelse. The instruction lasted 3\% veeka, at the and of which a postmest in probability was givea to 21 the subjects present.

## 

At the beginaing of the pilot atudy, all gecmed to be going on very woll. The regular methomatics teacher who was also the meadmaster of the nohool initially showed a very positive attitude towarde the whole programe. He indicated to the iverestigator that ho would be present during the experiment to gather some Idese on probability as ho himuelf was not sure of the
subjoct.

On wook later, the regulur mathematice teacher charged hie attitude. Be now anked the inventigetor to wind off his work slace the clas wer behiod and the reatod to complote Boak $51 x$ in 5 ine - that Ls before the and of the yorr. The iavantigater told the rogular teacher that the experiment had junt bogan add thit be atill had three wooks before be could vind oif hie wort. Bo reatnied the teacher that peruianion to oonduct the study in the school had been obtulaed srow the Municipal Education orficer and that the resulte of the ievestlgation would be beneficial to the whole countig. Ferthar, the experimatral antoriala and the proerramed booklote vould remin is the school. The inveatlgator felt that chooning anothor achool for the pilot atuly would be expupaive both is torm of tins and woraty as had scheduled the man study to atast in hay impediately the mohools open for second toan baulpens and all the prowteat and auction one of the promy had been ziven to the subjocte in the sobool. Aftor two dayy. the rogular olas teroher changed his nand and allowed the iavestigatar to continne. As has becn staned eurlier, the investiceator vas alloued flve periods a woek for his experiment while the
regular mathomtics teacher in the clasu noed tho remaing five mithometice periode.

It sbould be noted thet lack of co-operution wa only lintted to the teacher. the pupils on the other hand. showed mach enthonsam throuhout the experimant. Bren siouch the profils wese onthoniantic to the progreand materinle. the Laveotigetor atrongly leals tho attitude of the badmenter to the whole exerolse contributed exnatis to the pupilo. low achioranoat in tho post-tent.


Iten analyoin was earyied ont for all the toets urod in the pliot otudy. This was to find cut the appropriatenose of tho tocte to bo usce in the zain atudy. the mean and otrodan dorintion for anch teet worv comprated. Desides. the faollity valm for ouch iten. Item diserimisation fader, tho neliability ooefficinnt and the varlance of the proportione for each teat wors computed.

TABLE I

ITEM MUMBEAB

A) her booz mantionod iten were revised on the basie of the facility and diacrifination indicus obtuined. Por fraction itcen 3, 4, 11, 13, 16, 20, 21,22 and 24 were roviacd. Bat the values obtinined did not diffor mach from the original indscos. Bat ther was alight faprovmant. The facilitity valuos obtrined after reviaine the itcme worv -28, •39, 27, -35, -25, •3n, 228, -27 respectivoly.

The itcens on the Aritheotic reasoning, cilent moding and working with sumbers wore not reviacd though there wore some itema which did not diecrininate well botwoen the top $27 \%$ and the lower $27 \%$ \%or pont-tent item, iteme
 facillty valuoa vere as follouas .25, .32, .35. . 45 гespeotivelye Itean 27 - 20 mert 20 ft to challeace the iright atudente. The above table revoals that mun items mooded revision Dow to shortege of time, this could not be done and the inveatigator weat ahoad to adminiater the toatm. The aelection of each itce was lone on the basis of the fecility values and diecrinination indicen obtained. Items with facility valwos loes than 0.25 and diecrininntion indices lowor
than 0.2 wore rejected ab poor items. Sluslarly. Litas with facility values higher than 0.85 were regarded as of little noe as past of a manuring lowtrumont. Note that item with bloch discriniasting power axe good itches since they disorinfonte will between tho top $27 \%$ and the lover 27\%. If an item was rejected, mother one wal constructed and then retested. Filmily, the Itans thought to constitute good mounures had facility values append from a lower lint of 0.25 to an upper lind of 0.85 (1.e.e, $0.25 \mathrm{~K}^{8}$ $\leq 0.85)$. The table above presents a summery of the facility values, diecriainntion indices before the item e ware revised.

## TABLE?

## MEAMS. 5TANDARA DEYYAIICNS JARZAMCE OF

FROPORTIOMS AND RELIABILITY COEFFICXINTS FOR

## IHE PILOE STULY

| No. 08 | Mos of | Nearn | 50 | Var(P) | Nallabllty |
| :---: | :---: | :---: | :---: | :---: | :---: |
| subjects | 1 tens |  |  |  | Coefficiont |
|  | In the |  |  |  |  |
|  | cest |  |  |  |  |


| $\begin{aligned} & \text { Probabsilty } \\ & \text { Pra-tost } \end{aligned}$ | 44 | 15 | 3.22 | 1.77 | 0.13 | $\begin{array}{r} 0.53 \\ \left(R_{\bullet}, R_{0}\right) \end{array}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Norking } \\ & \text { Nith } \\ & \text { Numbers } \end{aligned}$ | 42 | 10 | 3.73 | 1.72 | 0.21 | $\begin{array}{r} 0.55 \\ \left(s_{0} \mu_{0}\right) \end{array}$ |
| Practione | 42 | 24 | 7.74 | 3.12 | 0.16 | $\begin{aligned} & 0.93 \\ & \left(x_{0} \cdot{ }_{0}\right) \end{aligned}$ |
| drithmetie leasonlng | 48 | 10 | 4.76 | 1.19 | 0.23 | (SoH.) |
| $\begin{aligned} & \text { Sliont } \\ & \text { Reading } \end{aligned}$ | 38 | 27 | 28.37 | 2.52 | 0.26 | $\begin{aligned} & 0.0 \\ & \left(n_{0} \cdot \ln \right) \end{aligned}$ |
| Frobabl 11 ty Post-test | 35 | 20 | 7.2 | 1.06 | 0.19 | $\begin{aligned} & 0_{0} B_{0} \\ & \left.\left(R_{0}\right)_{0}\right) \end{aligned}$ |

1. H. - splst - hals
K. R. - Kndarefigenardson

Keder - Picharioon foxmula $20\left(\mathrm{KR}_{20}\right)$ was
vand to onlculate tho roliability coerfickent of tho following teater probability promtest achiovenent. probability postriest sohsoreaent. Praction and silent Heading: the Tomiaing
 Beasonins woro uubjected to the 8pesiman - Brom forma (split-huls mothod) of culculating rcliability. It was found thnt kuder-itchardaon formen 20 jialdod ramsuily bioh reliablify conPliciente for theie two testa and bence it could not be appliad.

Table two above show the averace score. the varianoe of the seorea and tho varianco of tho proportion of oorroct anmere for oach item. 720 thoo 118400 . KieO was caloulisted we an index of the extent to rhich the variation of the subjeote" 5ew eooren wan a tru ladicetion of thale variation (27, 2972). Rnder-Fitchardson formia 20 in alao an indor of the oxtent to

17
Kents. J. Aol An Introduction to mantitative Pegroblogy. John iviley and Eans Anstrulasia pty Ied., 1971.
which scores on the second testing would reproduce scores on the first tenting. It is also an fedex of the extent to witch the items can be used to rani the avijects in tho sumo order.

In order to test whether or not the observed discrimination between subjects was 11kely to have risen by chance reapoanes, the following formula was used

$$
x^{2}(n-1) \cdot \frac{n(n-1)}{n(1-2)-1}
$$

wHere $a$ a mbibar of $1 t c m$ in the toast

- Tuderwilciardmon formula 20
*- Amber of subjects.

The value of the chi-square obtained for tho taste that ware subjected to Rudermilchardmon formula 20 were elgnsficant st the . Cl level of signslcance (Table 3. page 101).

This mean that the observe t discrimination between antjorts did mot occur by chance but could have been dee to som other factor, presibly Intel11genca.

## TAPR 3


25Crampon 250x

| Seal | R | ds | $z^{2}$ | 5 |
| :---: | :---: | :---: | :---: | :---: |
| Srabubusty |  |  |  |  |
| Pre-text | 45 | 43 | 110 | L.02 |
| gractions | 42 | 42 | 377 | L.02 |
| 21) |  |  |  |  |
| Tendtres | 38 | 37 | 227.9 | L.01 |
| Yxotabilsty |  |  |  |  |
| Sent-tent | 35 | 34 | 147.5 | L.02 |

Fable 3 above tiven the $x^{2}$ - vuluan fos the font testio.
3.5.1 The Reme for the main study

In Yobruary 1977 a llat of ull primary
Boboolm in Kisers was obtsined fras the Kinum humicipal rducation Ofsicer for the parpoce of seleotiag resenreh aubjects. alise the investigation to be carricd out invoived throe treatmante and in order not to diaturb the existing claseroce arrepreats in the schools, a $\bar{a}$ ecialo y yee ande to uelect ectroole with three atrucas of standard aix for the reasurohe incoordingly, a rindom aample of three schoole yith them strean in minndand aiz mag drewn nsiac random difit mombera. After the three eehools had been randoaly dramp the three ataadard aix classen in ench mohool vore randomy asadcred to esel of the follering trentmatal proyrumad instruction, (PI), procremod inutruction with teacher instruction in manl groups. (IPI), or conventiong alaseroom instruotion (CI).

Oricinally, the uample consintod of 447 pupile. whit 250 boyw and 197 girle. But for reasona not knona to the isvonticutor nor to the temohige asalistants. a sumber of pupile did not do all the toste adriniotered. Thene vere finally dropped at the rampais atan. loaving only 353 pupile -

- 103

292 boye and 262 8252n.

Bable 4 sbors how the gubjects were
diatributcd per treatnont in anoh acbool baloro the dropout. $A$ baic 2 I 3, aax $\times$ troutiont frotort-1 destig weo edopted for the experinext.

TASLE C:

## DTEEREMTIUN OF SUBJZCTE BEFCAS PACFOCUS

| 598 | sReatments |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | PI | 122 | CI | TOTALS |
|  | Boys | 30, 29 | 20, 30 | 29,30 |  |
|  |  | 27 | 12 | 28 |  |
|  |  | (3) | (77) | (6) | 250 |
|  | cirle | 21. 28 | 22. 19 | 16. 19 |  |
|  |  | 25 | 28 | 19 | 209 |
|  |  | (70) | (69) | (54) |  |
|  | Sotals | 160 | 145 | 238 | 48 |

Tho uncircled mamers in each cell represent the maber of subjects by sex in eech of the theee sumplo schoola. The cireled numbers represcont: the total muber of subjocti in esch celd.

The cable below shows the alstributlon of subjects res acheol per trentment after some pupis hed boen elfminuted at the smaiyals stage.

## 2rale 5z

## 

## TREATMLMES

|  | Boye | 82 | IPE | CI | COLNLS |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Sext |  | 22. 28 | 22. 29 | 26. 20 |  |
|  |  | 89 | 25 | 16 |  |
|  |  | (50) | (3) | (38) | 192 |
|  | 02128 | 21. 20 | 29. 25 | 16. 20 |  |
|  |  | 24 | 14 | 12 |  |
|  |  | (55) | (38) | (18) | 461 |
|  | Irtela | 123 | 124 | 208 | 353 |

The uncinclad mubers in acch cell reisesant tho muloar of subjecta ly ser in each of the threa cuple chools. The totel mumber of puplis for each celi is chown cysclec.
3.5.2. THG TREIGIEPS

The regular classrocu teachers in each eample sohool were used is this gtudy. It was not posaible to enliat the services of a aingle tencher in all the three classes as it wan found that this would interfor with the exiating armangemante in each nohool.

Bofore the iastruction comencod the investigater thoroughly truined all the teachere involved in the atudje All the three prograsiod booklets were eiven to each teachor. the fevestigator used thene booklyta as a basio for instraction. the training lasted four dayn. Inring the experimatal period the inveatigator viaited each school at loast twice wook neeting the teachere in oach echool and revioulag the progreas Escde by the puyile. During this tim the invostignter ulso reviured the proirra. The investigeter was satisiled that the teachers iavolved in the etudy now underatood probabillty which was the subject to be taught.

In addition to teaching the teaching asaistante the content of the aubjoct to be taufht, the iaveaticator aleo briofed the tesobere on bow to conduct pror,rniacd and conventional sosaions.

At the and of the teacher trinining, the toaching aseletants were handed the follouing premteate to administer to the aubjects nader their control:
a) A 15 - itu achievoment pre-test in probabilltys
b) a tast on childrens' readine abilitys
e) a test on childrma's general methomationd ablistys
d) punile astitude towneds mathematice.

Astor the pro-test administration, a course of instruction in probability wae eiven to the three troatment groups. A description of each of the trembenat ifioupe follows

## 

Three instrvotional methods - individualisod prozrend instruction (PI). integruted procramed ingtrection (IFI), and the cocerentiomal mothod of inatruction (CI) were used in the study.
(a) The individmalined Prourerimod Ingtruction (iJ)
he bee been mantianed in section 3.1.0, the progrea in probability was a linear one, of the Skinnar tjpe with 175 Irames writion by the invontigator of the present atudy.

The proile in this instructional group wat through the progran individmally and at thair ona pace. The teacher pased out the ifrest booklet so each pupil. the mupil roid a frano thea constructed his oun anewer to that fram on a suparate anawer shoet. The raswar was then compared with the ancwer given at the back of each pare. If the answer van correct, the puyil continued on. If tho anower van incorrnct the pupil reread the irmee uatil be maderntood ite After an indivictenl had completed a booklet ho colleoted another one iro the teacher. at the and of ench booklut there was esolf-test intended for self-avaluation. The ansvare were given following the test. The purpose was to enable the zupil to erede himself. EO toacher-made tenta mose givas to this Eroup.

The pryils in this t.ratment eroup sere not alloved to take the propren home with thome Thia wae to onsure that the aubjecte of all the three instructional Eroups were in contact with the lenraing materiala for appromately the com amount of tim. The teacher provided holp oaly to those pupils who songht help, othorwise he remained offoctivoly passive in the class.

Ho wea In clase thrughort the loiming seselon to angure thet the guibjecte did not chat by wortary from the erwore.

Eaoh temebor involvud with this group way acked to covertly reoond the tim knken by each pupll so complute each seotion of the procran and the maber of timan the tancher offared
 not atrictly adhered to by som teachara, whe arter keoplog the ruoerd for two days felt that the exereiso vas 2 aborioun and hence abandoned it.

## b). The Intecrated Frograymed Inatraction Groun (18T)

The subjactes in this group alvo ueed limeng procres siellar to the an maed by the Ledivicunised programed instruotion eroupe In additiun to tho projra, thile group aluo received teachar inatmotion. the pupile formed voluntary exoupe between two and four phille in each Eroun The pregran mas placed betwoen two prupile in occh group. Thay read a srano and cometructed thols anyern individually on soparato anewor aheots. The answor wert then compared uith
the anovery gives at the back of the page. If the papila 10 the ene sroup had the anme ansvore thet contised on. But if ans of then had an incorreot reepoave to a freme, they dracuiacd the material in the frame until thes all undervtood it. 18 , howevos, Efter tho diacussion some monber of the binoup had not minderetood tho material is the frome. thor consulted the teacher who helped then overoom thoir difficultion.

The teaoher of this instructional group vialtad cach ubrgroup frou time to time during the learning seaplan तlscussing wht the moubere -1 ench Erout the difficentiles they encometered in the rranes. Ie slso offered then hints for further disoundion on thair oum inscoptions were obuasta in one or two uchools wher the teachers coacerned loft the puple to go through tho propras alose vithout offexing thee belpe the inveatleater drow their atteation to the possible -fraets of theis bohaviour. jat this ald not change the mituation Fery mach is 000 soliool Where the tonching aselstant got involvod in eporting nctivition durion the lunt weok of Levestigatione The inventigator consldared it too late to rocrutt another teacher.

As in the procrained instruction eroup, no teachanmade teate more eiven to this groupe
c). The Ennwentional Instaruation Group (MT)

The pupils is this group received carvantional instructions (This method, recomen nded to be ulled in the primsty sobools of Kony. is usually reforred to as tho Guided Discovery hiethod).

A booklet in probability containing tho sun enterial ne the proymin un constructed by the inveatigator and lamod to each toscher involved with the cI Eroupe Tho temcher prepased hie daily leasons from the leacon buoklets. Whe peyile worked in grouph of four thrombout the loarniag searion. The teachar posed grastives to the pupile to holp then ilscover mathematical relationolipe. Unlike the papile in the il or IJI grouph. papils in this group war given acuraises to bo cone in class and at home. The toacher marked theue olaus exorolsoe and homowork ascignaente and then discuseod the asalenmonts in cleas. At tho ond of each aectios theteachar adainiaterad a ahort toat to the mabery of this gromp. The teat was constructed and mertad by the teacher.

It should be noted that the puilis in thile room were not fiven probability boakete. Ratbor, the teachor wrote the problums for disen asion on the blackbourt. The experimontal astertals were made available to the just an in the other inctructional crouple.

## 

At the cloae of the instruction which lasted foar vedk, a 20 - ite probability tout was administared to all the eubjocte in the atudy. 412-Iten attitude towarde the propram questiomate whe also admalatered to the aubjocts is the procirmand instruction and the lutogreted programad inatruction croupa. inght wook luter, a retentios tost was adrinisternd to ald the aubjecte in the atudy.

Tho normul matbontice twachor admindatered the teate during double mathentioe leseone. the inventigatar collected the anawor geripte from the schoole.

The testa mert Enxted maralily by the Laveatigntor. For the tosts, one mark was awanded for each corrwot ungwer, an 8 for more than two respomion to ma iten, and as 9 for a misaed our
response. In the manjyal of data, oniy a correet response and en incorreot reaponce were considered. An her bean mentioned earlior, the ectitude questionnalu itcas $\quad$ ere given difierential sooves of $+2,+1,0,-1$ and -2 accordins to uhethor an item hod a positive or maralive conrotatiun.

4 dod calculator was used for data analyese.

### 3.5.5. COITHEL

In a studs auch as the prosent one. it is often disficult to bold all variables constant excopt the experimental vorlable which we wieh to munipulate throuh our experdeontal trvatreat. Ia chis atudy an attexpt haw been made to cootrol for sowe orrors that would have been extranoors to the jurpesee of this invostisatione such orrore and how thay were possibly comirolled for are listed belows

1. To control for the conteats to be studied, the invastigator prepared lossom naturiule from the prokramed materifls. The progren and the lesson wore tbervfor comparable in atyle and dirsiculty.
2. Cnllaren's matural interest in erase providow a high level of motivation for the study of probablilty. This atudy capitalised an that intereat by reing experincestal activitics to introduce acme of the basic sdeal of probablity.
3. It ras oonsidered that the coovontional mothod explefing the soe oxperimantal meterials would have ainilur novelty value as the progrenad inutruction or the intornated procrent inatmuction mothodm, and thet this would bolp to balance eny "havthoren kifecte."
4. The eubjecta wore avare that they were involved in an experimont, as this was relayod to thea by thair malimatics toachore. They bowever. were not aware that they wer belas aubjootod to difforent trentmente. Iurther, tho inveatigater did not infore the teaching asalstants of his hypotheses. It was hoped that thise would melp to onncel out the "rocenthel isfoct."
5. The mothodolodoal ariore due to different tenchere wert controlled for by thoroughly tralating the teachers in the gubjoct to be tought. Before Erailaing, the teachere had lsttle kowledge of probability as was
exemplified by their responses to the questions posed by the investigator before commencing the training programe. After training and gubseçuent review of the topic during the course of the experiment, it was hoped that teachers wore on the same level of understanding of probability.
6. The investigator did not visit the classrooms Irequently. Rather, he conferred with teachers in each school at least twice a week. During these meeting the teachers reported what thes had observed in their classes and the problems they had encountered when handling probability.
7. Before the start of the investigation, all subjecta were assumed to be initially comparable. However, after the pre-test probabilits scores had been aubjected to a one-way analysis of variance, the assumption of the initial equality of all the subjects in the study was not supported. Hence a two-way analysis of covariance was used to control for any factor that might have been responsible for the differences among the subjects.

## 

i. bas bean manciomed elsonber in thle chapter. toachere insolved in this stady met froguantiy with the invastigator to repert thoir observation in the clasarooms. In these moting many nseful thoas wore discursed. Uome of the grogranod instruction teachere oanpleinod that the progran was too loas and that 21 they contianed uring it, they would not be sble to cover the syilaber by the and of the joar.

Toschers of all lastructionnl croupe reyortod that purile ware highly athrosiatic, eapeololly what usiog experimantel materials like dico, marbles. otc. Feaher of the 81 groupa reported sooing voluatinxy roups boine formed in the clasarocen, un indication that pajile cancot read the progrea wbolly on thols ow wthout eeeklay the asglatance of othor puils. thite confires ibenghart ${ }^{\circ}$ ( 7.2963 ) contention that proper use of progronmed materiale can be mene if they are cumbined with iencher inotruction.

It he il tenchare also reported seating
pule at siret harry through the proirion as if it was a cont. But the slow ad dow after some time with students settles dow to a more serious work. Most of the prosit in the PI group ware seen working frow the answers. That wis, however stopped by thole teachers.

## GRIPTER FOUR

## FRNDEGS

### 4.0 IRTRODUCTIOI

This chapter outlines the techniques of analyais used and describes the lindinge pertinont to each hypothesia as given on page 8 chapter one.

The initial probability achievement test was subjected to one-way analysis of variance. This is described in section 4.1.1. Yollowing a significant analyais of variance, a echeffe' test for post-hoc comparisons was computed to determine which of the means were aignificantly differont. This statistic is described in section 4.1.3.

Por testing the mull hypothesis of no differencee among the treatment groups at ach of the four cognitive levels with respect to the criterion variable, a two-way analysis of covariance was computed. A twoway analyais of covariance was also used to find out which of the treatment Eroupe under inve tigation had a hicher retentive power at each of the four cognitive levels. A description of the assumptions underlying the anslysia of
covariance is given in section 4.1.4.

Following a rejection of no differences anong the means of the treatment Eroupe, a special t-test wan conputed to dotemino which palr of means significantly differed. This etatiatic is deacribed in section 4.1.5.

The ordinary tatest was computed to test for aignificant differences between the means of boys and girla in the pre-test probability achievement, mathenatical reasoning, reading ability and attitude inventorles. The asaumpions underifing the t-ntatistic are reported in section 4.1 .2.

Pearaon product-moment correlation coefficients were computed between prediotor variables mathematical ability, silent reading ability, attitude towards mathematics, attitude toward the program, and probability post-test scores, to find out which of the predictor vaxiables significantly predic ted achievement. The pro-test and post-test probability scores wore each correlated with probability retention scores to deteruine which of the two predicted retention.

#  POR DATA MHLTEIS 

Before the start of the investigation, a pro-test probubilits achiovement, matheatics ability teat, silent reading ability teat, and attitnde towards mathematics questionnaire were adrinistered to all the aubjects in the study. 111 these teste were aubjected to a one-way analyeis of variance to test for differences among treatment means. The ascuptions underlying this etatistic are listed below.

### 4.1.1. ASBUTRPIOTS UHDERUTIEG IHE Y-THST

1. A11 the treatment groups are drawn randomis Iron noreally distributed parent population.
2. The variance of each treatment population Ls the same.
3. Observations represent rundom samples from populations.
4.2.2. AgSUPFIGM OF THE t-test
4. The scores in each of the two populations Irom which the firoups are randoms selected are normally distribated (ascumption of normality of the distribation).
5. The variances of the scores in the two popalations are equal (the escuraption of momogencity of variance).
6. The two eroups are independently selected.

### 4.1.3 SUPPLEYENTARY MALYSIS FOLLONING ANALYSIS

 OR VARTAMCEPollowing a significant $Y$ in the context of analysie of variance, a scheffo test for post-hoc comparisons was computed. The various t-tests following acalyais of variance are nutually interdependent and hence would not be ideal in this case. two poiats are advanced about the Scheffe' procedure.

1. The mothod is oxceedinely general in that it asy be applied recardiess of the mumber of means under study and regardiess of the number of cases in each group.
2. The sohoffe' test is very concervative, thus leading to relatively fer significant remults.

The principal reason for the conservation of the scheffo' test is that the associated
shenillonen loval (0.8. .05) applies gimaltanously to all ponsible scherfo' comparisome.

## 

## 0 OOVARTANCE

1. The oriterion scorme is elloh group mat be reparded as a random cample from a population of jossible meores.
2. The covariate moasures are unifectod by the treatmants.
3. The represulion of the X -scores (the oriterion measure), the maguse forming the basis of the adjusternt is the same for all the populaticns.
4. The adjuited scones in esch of the popalistiare are mornully distributed and have the aame reriance.
5. The mean of the edjonted scores is the sem for all treatnonat populatione.

##  Anturids of Covailance

Pollowing a rejection of the mull hypothosis of no cifference between the means of the samplea
on the bata of an annlyale of covoriance, st wea nccessary to ceternine mith palre of mens digfered sicniflcently. To to this. sonelal E-kat ves conputect. The follonim Yoreula gives the erras varlance of the difference whmen two cdjusted cafterion maces $\vec{Y}_{2}^{1}-\bar{Y}_{j}^{1}$.

and

$$
t=\frac{\bar{q}_{i}-\bar{v}_{i}^{\prime}}{\sigma_{v_{1}}-\bar{x}_{j}^{\prime}} \text {, }
$$

whare.

$$
\begin{aligned}
& \text { n } \mathrm{B}_{1} \text { sanizio elan for group is } \\
& \left.n_{1} \text { - semple sise for granp }\right\} \\
& \mathrm{F}_{1} \text { - men for the momelurer for growp is } \\
& \bar{x}_{y}=\text { mean for the x-mensures for group } y \\
& \text { If edjucead critarion maan for group } 1 \\
& \text { T\} - edjustad criterion meen for group }\} \\
& 5 s_{W} x \text { - withipmgroups suan of equares for the } \\
& \text { y-masures } \\
& \text { ss }{ }^{\mathbf{1}} \mathrm{W} \text { - ajucted withlmagroupm mean equares } \\
& \text { for the eriterion meacuras } \\
& 0^{2}=\text { arsor verience of the diflectence } \\
& \text { betwon two cajusted eriterion mean }
\end{aligned}
$$

## d.1.6. GORAERATIOHAL STUNTES

The purpeen of performim e corrolational
analysin wan ko study the relation between the Indefencent varsiblee gueh an attleve towarde mathematice, attltudes tomards the progrem, mathematical roasoning, recellng abllity, and prebabllity post-test. specificaliy, the stiady almod at finolng out unich of the Indegendent varisbles wan - gmod pridictor of achievement in a probability protmecet.

Corrolatisn repeflefente ware also computef ts determim inlen of the twor pro-fest rinleveaeat or pastotert sehiswemant, was a bettar proclstor of retene1.on.


## 

As has besa stated sarlies in the introductory part of this chaplar. promest probabillty achlevenent scores vere subgocted to onowsy analysla of varlance. The ansuaplions cimeurning thes seaslstic mevo been given in eactlon 6.1.2. the maks and stendard doviations for esch instruction group have beon ccoputed. Table 6 gives a suranary of tha geaults.

## TABLE 6:

## MEANS AND SLANDARD DEVIATIOS FOK THE PRETEST

## PIKOBABIITTI

|  |  |  |  |
| :--- | :---: | :---: | :---: |
| Cognitive | Programmed | Integrated | Conventional |
| Level and | Instruction | Prograumed | Instruction |
| Sex | $(P I)$ | Instruction | (GI) |
|  |  | (IPI) |  |


| Knowledge | 1 | I | SD | H | I | SD | N | I | SD |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |

Tatal Scores $123 \quad 53.0 \quad 22.09 \quad 124 \quad 47.6 \quad 26.810648 .8 \quad 27.0$

| Male | 68 | 55.5 | 24.37 | 66 | 49.2 | 27.7 | 58 | 55.2 | 27.6 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Female $\quad$| 55 | 50.0 | 18.65 | 58 | 45.7 | 25.7 | 48 | 41.1 | 24.5 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

## Comprehension

Total scores $123 \quad 34.3 \quad 26.47$ 124 $36.527 .310630 .0 \quad 24.98$

Male |  | 68 | 36.0 | 26.06 | 66 | 39.4 | 27.8 | 58 | 31.9 | 28.41 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Application
Total Scores $123 \quad 16.6 \quad 14.22 \quad 124 \quad 17.5 \quad 12.810615 .111 .5$
Male $\quad 68 \quad 15.6 \quad 13.37 \quad 66 \quad 19.1 \quad 13.3 \quad 58 \quad 14.011 .0$

Pemale $\quad 55 \quad 17.9 \quad 15.23 \quad 58 \quad 15.712 .1 \quad 48 \quad 16.411 .98$

Analysis
Total Scores $123 \quad 26.0 \quad 14.92124 \quad 19.0 \quad 15.8106 \quad 20.215 .2$

| Male | 68 | 26.8 | 14.91 | 66 | 20.0 | 16.5 | 58 | 21.4 | 16.7 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Pemale $\quad 55 \quad 25.1 \quad 15.02 \quad 58 \quad 17.915 .1 \quad 4818.8 \quad 13.3$

$$
=126-
$$

Table 7 presents a aumary of a ono-way analysie of variance for probubility pro-test achievenont.

TABLS 78
ANALYEIS OF VARITANGE FCQ PRTOTEET PROBURILTIT


- $P<.01$

An exnination of the above table Noveale no significant differences anong the man of the PI, IMI and CI groupa in the tonoledge, comprehansion and anplicution lovels. Bronificent difforencen however, existod anong the mean of the three instrectional igroups in the analyis level ( $1=7.26, P<001$ )

Since a Eienificant P-ratio was obtained in the analjels level, acholfe" tost lor post-hoc conparisonn wan conputed to determine which pairs of Bern vere sigaificantly difforeat. Table 8 chow a comprison of different pairs of menn In the three treatment groups in the Analysis 20vel.

## 

##  <br>  <br> 



[^4]The resulte presented in the above table show that a aignificant difference exdeted between the progranmed und integrated programeed Lastruction groups at both the 95\% and 99\% confidence intervals, with the proframmed finstruction group $(\mathbb{Z}=26.0 ; S D=14.92)$ performing significantly better than the integrated prorramed instruction group (X $=19.0$ s SD $=15.79$ ). Since the null hypothesie thit the difference between the reans of the two instrnctional groups is sero is not included in the two confidence intervals, wo are relatively confident that the means for the pupils in the IPI group wes from 2.2. to 11.8 marks lower than the nean for the PI pupils. In the $99 \%$ confidence interval, the mean for the IPI pupila was from 1.03 to 12.97 lower than the mean for the PI pupils. There wac a significant differonce betweon the menn of the programed instruction groxp and the mean of the conventional inatruction group at the $95 \%$ conildence interval. the protransed lastruction group (X - 26.0; $B D=14.92$ ) perforatas auch better than the conventional instruction group (X - 20.2; $S D=25.42$ ). The man for the CI pupil: was from 0.8 to 10.8 points lower than the mean for
the pI puplls. The means of the 128 and the CI oroup ere statistscally inalgnigicent (d - 1.2, P> 03), mere drafur to the ciffermeet between meanse

In oreer to throw more 18 ght on the overal performance of boys and airle in pro-tent probebilley In the four cognitive loveln, a teart wa computed. The remite of this statistic cre oumentiend in teble D. There wao mo signiflcant diflerance betweon the meant of the two sex groupe In the enalyale cognikswo level. (t - 2.331 P>.03). Nor were there algnifieant ilfferances in the mpplication eognitive 1evel (t - 0.202 P> 031. ilgndisenat diflerencon, howver, enleted on the knowledge (t - 2.7 $<008$ ) and on the compreheneion (t - L.07f $P<003$ - one - talled) cognttive levels. The algndflcat difference was in favour of boys In both ence.

## 2A3E 20

COMPADISLA OF THE PLEFOMNME OF OTS NNH GIHLS

| Yerlablesen | - 1 | , |
| :---: | :---: | :---: |

Knowlendon

| eoysi | 292 | 53.3 | $26.57)$ |
| :--- | :--- | :--- | :--- | :--- |
| cisios | 162 | 45.80 | 23.03 |

Comorernenilon

| 80\%38 | 192 | 39.9 | 27.39) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| - |  |  | $)$ | 1.67 | $\angle 0.0$ |
| cerles | 162 | 31.2 | 23.003 |  |  |

Agollatilo:

| 80988 | 892 | 16.3 | 12.73) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | 0.29 | (43) |
| cerles | 251 | 26.7 | 23.84) |  |  |

Ancynt

| Bores | 292 | 22.8 | 16.2) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | 1 | 2.33 | (ms) |
| G2xas | 168 | 20.6 | 10.22) |  |  |

##  ACHTBTETENT

The assumption of the initial equality of the groups was tested by a oneway analysis of vamance. The results have boen sumanrised in tables 7 and 8. There are no significant differences in knowledge, comprehension and applicztion levels in the context of anova. Bignificant differences, however, existed in Analyais lovel. The Bignificant ifferences indicated a need for statistically equating the groups. Subsequently, e two-way analysis of covariance was computed for this level. In order to increase the precieion of the experiment for the other three copnitive levele, the two-way analysis of covariance was computed, even though no significant differences had been found anonk the means of the three treathent groups in these cognitive levels in the context of anova.

As has been mentioned in the foregoing paragraph, treatment groups were compared for probability achieverent by a twomway analysia of covariance. Teaching nethods and sux of pupil served as the main offects with the

- 133


#### Abstract

pro-iest probablifty scores as the covarlate and the pert-tent scores en the criterlon Eefore computing the ambyise of covarlance, the mant and etanderd oufation for the ereationt groups and sam groups nere computed. for each cognt tive level. rable 10 presents a mumary of the mans and standard devietions Anile table 11 gives a sumary of the aniygis of coverlance for all cognitive levele, and ceole 22. page 136 gives the edjusted means for the enbjects in the three trentiment groupt.


## TABTE 10:

## 

## POST-TEST SCORES



## Knowledge

Total Scores
Male
Female

Comprehension
Total Scores Male

Female
Application
Total scores
Male
Female
Analysis
Total Score
Male
Female
$12359.821 .1412460 .125 .69106 \quad 62.722 .69$ $68 \quad 60.721 .74 \quad 66 \quad 63.625 .64 \quad 58 \quad 60.8 \quad 21.52$

$12351.623 .912453 .021 .41106 \quad 55.223 .07$


12344.116 .1612446 .615 .2610648 .117 .74 $6849.116 .03 \quad 6646.214 .14 \quad 58 \quad 48.018 .93$

$123 \quad 36.716 .8612440 .518 .12106 \quad 42.615 .63$
$6836.218 .69 \quad 6639.718 .73 \quad 58 \quad 41.414 .92$
$\begin{array}{llllllllll}55 & 37.5 & 14.43 & 58 & 41.4 & 17.51 & 48 & 44.2 & 16.48\end{array}$

## TH14 11:

## 

| $\begin{aligned} & \text { jource ot } \\ & \text { varsa- } \end{aligned}$ | Irachin; rethocs |  |  |  | 2ex |  |  | interaction <br> (Tietrec $x$-ex) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| vel 1 vi | Sj |  | 353 | $F$ | Su | df | $\cdots$ | $F$ | 3 | C | \% | $F$ | 53 |
| Knowlide | 697.09 |  | 348.54 | . 651 | 155.52 | 1 | 155.52 | 6.271 | 2373.23 | 2 | 1106.615 | 2.22 | 185175. |
| compretension | 654.13 |  | 327.7 | 0.644 | 24.2 | 1 | 24.2 | 0.645 | 58.48 .45 | 2 | 2924.225 | $5.76{ }^{\circ}$ | 175736 |
| -9pllcation | 1063.813 |  | 534.44 | 1.101 | 114.92 | 1 | 114.92 | 4.4तो | 3186.43 | 2 | 1573.21 | 6. 19 | 87976.1 |
| nalymis | 2386.73 |  | 193.37 | 4.13* | 366.68 | 1 | 366.t. 8 | 2.266 | 20.9 | 2 | 10.45 | C. 04 | 100061. |

## TABLE 12:

## DEEATP:NN: CROUP NEANS FOST-TEST SCCRES

## ABUUSTRE FCR MBR-

| $\begin{aligned} & \operatorname{cognd} \operatorname{low} x \\ & \operatorname{lovi} \end{aligned}$ | Ireatmant Group | $\square$ | Means | $5-$ Mane | Adjusted Y-hane |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Knoul ${ }^{\text {dode }}$ | $P 2$ |  |  |  |  |
|  | Poye - | 63 | 55.5 | 60.7 | C0. 14 |
|  | Glale - | 53 | 5 Sc .3 | 58.6 | 58.59 |
|  | IPI |  |  |  |  |
|  | Boy - | 66 | 49.2 | 63.6 | 63.69 |
|  | G1525 | 58 | 45.7 | 56.0 | 56. 12 |
|  | Boye - | 50 | 55.2 | co. 8 | 60.27 |
|  | G252s - | 48 | 41.1 | 65.1 | 64.22 |
| Comprehenalon | P8 |  |  |  |  |
|  | Poys - | 68 | 36.0 | 46.3 | 46.38 |
|  | G1585 | 55 | 32.3 | 58.2 | 58. 14 |
|  | 2P8 |  |  |  |  |
|  | Beys - | 66 | 39.4 | 55.3 | 55.51 |
|  | 62588- | 58 | 33.2 | 50.4 | 50.38 |
| Applleatson | CI |  |  |  |  |
|  | Soys - | 58 | 32.9 | 57.8 | 57.73 |
|  | CIr80 | 48 | 27.6 | 52.1 | 52.37 |
|  |  |  |  |  |  |
|  | $\begin{aligned} & \text { Boys } \\ & \text { Gleds } \end{aligned}$ | $\begin{aligned} & 68 \\ & 55 \end{aligned}$ | $\begin{aligned} & 15.6 \\ & 27.8 \end{aligned}$ | $\begin{aligned} & 49.2 \\ & 37.8 \end{aligned}$ | $\begin{aligned} & 49.35 \\ & 37.56 \end{aligned}$ |
|  | 291 |  |  |  |  |
|  | Boye - | 66 | 29.1 | 46.2 | 45.76 |
|  | 08528 | 58 | 25.7 | 47.1 | 47.23 |
| Analyse | C 2 |  |  |  |  |
|  | Soys - | 58 | 14.0 | 48.0 | 48.12 |
|  | G25ds - | 40 | 16.4 | 48.2 | 48.22 |
|  | P2 |  |  |  |  |
|  | Poys - | 66 | 26.8 | 36.2 | 35.9 |
|  | 6icle - | 53 | 25.1 | 37.5 | 37.3 |
|  | SPI |  |  |  |  |
|  | boye - | 66 | 20.0 | 39.7 | 39.8 |
|  | Cic1s - | 58 | 27.3 | 42.4 | 41.6 |
|  | C 2 |  |  |  |  |
|  | Boy | 58 | 21.4 | 41.4 | 41.4 |
|  | 62519 - | 48 | 18.8 | $40^{2}$ | 4.4 |

### 4.2.2.1 ANALYOIS OF POST-TZOT FBOBUBIITTX

 SCORG ON TH: KONDDGE COGNINIVE
## LiveT

Table 11 shows no significant F-ration Ior sex, teaching methods or method by sex intermction on the knowlede copnitive level. Though no aignificent differences are revealed on this lovel, an examination of table 12 shows that the programed instruction boje (adjusted mean 60.14) perforned better than the Gisls of the same instructional group (adjusted mean 58.59). The integrated programed instruction boje (nean 63.67) did better than the girla of the same group. The conventional Lnotruction boys, on the othor hand, showed a relative inferiority in their performance to thut of the firls in the same eroup (adjusted mean for bojes 60.27 and adjusted nern for kirle 64.22). On the whole, the girls who went through the conventional instruction perforied slifihtly better than the boye and the girle of the other instructional Eroups. It can be inplied from the foregoing discussion of results that girla leam specific lacts better when they are tauribt by the bunan teacher than when they are taught by elther the profran or the progran aupplemonted by the human teacher. Boye
who learued from the program aupleronted by the teacher were alightly auperior in performance to those who were taught by the program or by the human teacher.

### 4.2.2.2. ANWISTS OF PROBABIMTY 1OGT-TEST

SCORES OH COMP 2 PIE:SIUE COGMITIVE IBVEL

An exemination of table 11 reveals that
there were no significant differences with regards to teaching mothods and sex. However, signilicant aifferences existed in sex by methode interaction ( $P=5.757, P<.01$ ). To gain further insight into the nature of these differences, a special t-test following a significant analysis of covariance was computed. The rosults of this statistic are presented on table 13 below.

$$
-\quad 139
$$

TABLE 13:


## 

| Treatmant Sen Grone | c | $\bigcirc$ |  |
| :---: | :---: | :---: | :---: |
| P1 and EPI | 2.34 | $<.05$ | C.02 (onoct |
|  | 1.832 | $<.08$ | (omomtal 20 ) |
| PI and CI | 2.815 | <.02 |  |
|  | 1.107 | $>$-03 |  |
| IPI and CI | 0.345 | >.05 |  |
| cicis | 0.338 | $>0.05$ |  |
| PI Boys and pi Gisla IPI Coys and IPZ G2rle | 2.875 | <.02 |  |
|  | 8.262 | $>.05$ |  |
| CI Boyre and CI Cirie | 2.33 | $>$.0s |  |
| PI Doy and IPI GLELE | 0.882 | $>.05$ |  |
| PI soys and CI Giela | 1.266 | $>.03$ |  |
| PI G1ris and XPI aoys | 0.638 | $>$.05 |  |
| PI Giris and CI Boys | 0.0978 | $>.05$ |  |
| IPI GIrla and CI Eioys | 1.757 | $<.05$ | (coertalled) |
| IPI Girle and Cl Glelo | 0.34 | $>\cdot 05$ |  |

The results of the special t-test revealed the following:

1. (a) There was a significant difference between the boys of the PI group and the boys of the IPI group $\left(I^{1}\right.$ PI $_{G}=46.35$, $\frac{1}{I}=55.51 ; t=2.34, \quad P<.05$ and I CPI ${ }_{b}$
PL .01, ono-tailed), the difference being in favour of the IPI boys.
(b) For the girls of the two instructional groups, the PI girls performed better than the IPI girls $\left(\overline{\mathrm{Y}}_{\mathrm{PI}}^{\mathrm{g}}=58.14\right.$,

2. (a) There was a significant difference between the boys of PI and those of the CI groups, with the CI boys' performance being significantly superior to that of the PI boys $\left(\bar{Y}^{2} \mathrm{CI}_{\mathrm{b}}=57.73, \bar{Y}^{2} \mathrm{PI}_{\mathrm{b}}=46.38\right.$, $t-2.815, P<.01)$.
(b) the girls of the same instructional groups did not differ significantly in their performance $\left(I^{1} \mathrm{CI}_{\mathrm{g}}=51.67\right.$.

1 $\left.\overline{Y P I}_{\text {PI }}=58.14, \quad t=1.407, P>.05\right)$. 9
3. (a) There were no significant treatment effects for the boys in the IPI group and those in the CI group $\left(\frac{1}{Y_{\text {IPI }}}=55.51\right.$, $\vec{I}_{\mathrm{I}}^{\mathrm{I}} \mathrm{b}$-57.73,t$\left.=0.545,{ }^{b} \mathrm{P}>.05\right)$ although the CI eroup boya performed relatively better than the IFI group boye as evidenced by their mean scores.
(b) The girls of the game treateent groups did not exhibit any significant differences in their performance $(t-0.339) P>.05)$. The performance of the girls in these two instructionul eroups was almost comparable. The adjusted mean for the IfI girle was 50.35 while that for the girls of the CI group was 51.87.
4. The boye and the girls undergoing programed instruction differed aignificantly in their performance $\left(\bar{Y}^{2} P I_{b}=46.38, \bar{Y}^{2} P I_{g}=58.14\right.$, $t=2.875, P<.01)$, with PI gilis scoring higher than PI boje.
5. There was no significant difference between IPI boye and IPI girls ( $t=1.262, P>.05$ ) though from the mean scores, boys in this instruction group $(\vec{I}=55.51)$ performed better than girle of the sane group $\left(I^{1}=50.38\right)$.
6. The performance of boys and girls undergoing the conventional mode of instruction was not statistically aignificant ( $t=1.33, P>.05$ ). Judging from the mean scores, boys who learned through this mode of instruction $I^{1}=57.73$ ) did better in the probability achiovement post-test than girls who learned through the seme method ( $T^{1}=51.87$ ).
7. Ho difference between PI boje'and IPI girla' performance was observed ( $t=0.991, P>.05$ ). However, the IPI girls $\left(Y^{2}=50.38\right)$ did better than the FI boys $\left(Y^{2}=46.38\right)$.
8. Although the difference between the adjusted means of the PI boye and CI girls was not statistically significant ( $\mathrm{t}=1.286, \mathrm{P}>.05$ ), the CI girle' performance ( $I^{2}-51.87$ ) was sonewhat superior to the PI boyn' performance $\bar{Y}^{1}=46.38$ ).
9. Mo aignificant difference was found between PI girls and LPI boye ( $t=0.638, P>05$ ). But the PI girls $\left(I^{1}=58.14\right)$ did slifhtiy better than the LPI boye $\left(Y^{1}=55.51\right)$, judging from their mean performance.
10. No significant difference was observed between the PI girls and the CI boys ( $t=0.0978, P>.05$ ). The means for the two sex groups were quite close ( $\bar{Y}^{1}$ PI girls $=58.14$ ) and ( $\bar{Y}$ IPI boys $=57.73$ ).
11. The girls who learned from the program supplemented by the human teacher i.e. the IPI girls, and the boys who learned from the human teacher alone i.e. CI boys showed significant differences in their achievenent scores ( $t=1.757, P<.05$, one-tailed). The significant performance was in favour of the CI boys $\left(T^{1}=57.73\right)$. The mean for the IPI girls was $\bar{F}^{1}=50.38$.
12. The girls of the IPI group and the girls in the CI group did not exhibit any significant differences in their performance ( $t=0.34$, P >.05), though the mean performance for the CI girls was slightly higher than the mean performance for the IfI girls.

From the forgoing discussion it is clear that boys do relatively better in comprehension tasks when they are taught by the human teacher while girls do well when they learn through selfinstructional materials. It should further be
observed that the mean performance of the girls who learned through the program was relatively higher than the mean performance of the other subjects. The finding that girls seem to learn better through self-instructional materials is contrary to the findings on the knowledge level where girls were found to perform better on knowledge tasks when taught by the human teacher.

### 4.2.2.3. ANALYSIS OF POST-TEST PHOBABILITY

 SCORES ON APPLICATION COGNITIVE LEVELThe results of the analysis of covariance used to test for the significance of the difference in probability achievement in the instructional groups, i.e. the $\mathrm{YI}, \mathrm{IFI}$ and the CI groups is presented on table 11, Page 135dable 12, page 136 give the adjusted means for the subjects in the three treatment groups.

There were significant main effects for sex ( $F=4.487, P<.05$ ) and for sex by methods interaction ( $F=6.187, P<.01$ ). There were no significant differences for teaching methods. The aignificant interaction revealed by the twoway analysis of covariance called for further analysis to determine which group interacted with which method. For this reason a special
t-test was computed. Table 14 presents a summary of the results.

$$
-\quad 145
$$

## TARLE 14:

## 

## COYARTANCL CH ABPLICATRCN CCOMTTIVE

## REVET

steatemt Group

II boya and IPI boys PI boys and CI boye ETV giria an CI glele Pl girla and CI ofsia PI boya and CI boys
PI girla and IPI gisio
fi boys and PL girls
PI boye and IPI qisis
PI gisle and CI giele
IFI boys and IPI girla IPT Boys and CI girio
CI boys and IPI gisio
CZ boye and CI 9\&rio
CI boys and PI glxis
IFI boye and DI girie

18
$1.290>.03$
$0.329>.03$
$0.315>.05$
$3.38<.01$
$0.827>.05$
$3.218<.01$
$4.072<.01$
$0.333>.03$
$0.37 \gg .05$
$0.522>.05$
$0 . \cos >.05$
$0.398>.05$
$0.054>.05$
$3.102<.01$
$2.826<.02$

The table reveals that only five pairs of mean were significantly different. The remaining ten paire wore not aignificantly different; at the 0.5 level of aignificance.

1. There was a significant difference between the performance of the PI girls and the performance of the CI girle ( $t=3.38$, $P<.01)$, with the CI girle $\left(f^{2}=48.21\right)$ perforulag significantly botter than the PI girls $\left(\bar{Y}^{2}=37.56\right)$.
2. The girle wedergoing programed instruction suppleanted with teacher instruction $\left(I^{1}-47.23\right)$ did aignificantly better than the girla who learned through the progras only ( $t=3.218, P<.01$ ).
3. The בean performance of the PI boys ( $^{2}=49.35$ and the moan performance of the PI girla ( $\bar{Y}=37.56$ ) were aignificantly different ( $t=4.072, P<.01$ ) the difference being in favour of boyz.
4. The performance of the boys who received teacher instruction ( $I^{1}=48.41$ ) was eignificantly euperior to the perfermance of girle who went through programmed materials individually $\left(I^{2}=37.56, t=3.602, P<\cdot 01\right)$.
5. When a comparison of the performance between III boys and PI girls was made, it was found that the performance by the IPI boys $\left(\frac{1}{}=45.76\right)$ was significantly superior to that of the HI girls $\left(Y^{1}=37.56\right) t=2.816$, P<.01).

From the forgoing discusaion, it seems appropriate to conclude that girls performed sigailicuntly better in an achievement test when they received teacher instruction than when left to study on their own through the proeran on the applicution cognitive level. This is evidenced by the relatively low mean of 37.56 for the girls wo received individualized pregranmod instruction.

It is inturesting to note that boys who went through the program on their own performed relatively better than those who received proframed instruction supplemented by teacher instruction in suall groups. Another interesting observation comes to likht when one considers the performance of the pupils who received Conventional instruction. The difference between the means of bojs and Eirls in this group

Was atatistically insignificant ( $t=0.0642$, P>.05) and negligible. This can be interproted to mean that boje and cirls who received this instruction learned equally well.

When the performance of all the boye and all the girls in the study was considered boys' performance was somewhat better (means $47.8,50=16.33$ ) than that of girls (nean 44.2. $S N=16.30$ ). On the whole, the CI group $Y=48.33$ ) performed better than either the $\operatorname{IFI}\left(I^{2}=46.43\right)$ or the $\operatorname{PI}\left(Y^{2}-44.08\right)$ groups.
 SCORLS ON AWALYBIS COGNLIIVL LEVEL

The results of the subjects' performnnce on thie cogntive level are sumarised on tables 11 and 12. Table 11 given a summary of the analyais of covariance for post-test probability acores adjusted for pre-teat probability scores while table 12 presents a sumary of the treatment group means for post-test probability adjusted for pro-test probability scores. There was a alpnificant treatment effecte ( $F=4.126$, $P<\cdot 05$ ). Pollowing this aignificant $P$ in the context of ancova, a special t-test was again computed to find out which pair of means were significantly different. Table 15 gives the results of the apecial t-teat.

## BABㅜㄹ 188

## A SPECLAL tetnent o: AMALXSTE MEMA3

| Treatment Group | elfferanco batwaed means (a) | * |
| :---: | :---: | :---: |
| PI and IPI | 4.24 | 2.50* |
| PI and CI | 6.3 | 2.76 |
| IPI and CI | 2.02 | 0.80(45) |

- P<ecl (onomalied)
- $P<.01$ (fromenllad)

The Eigniflcant differences lavoured tho IPI and the CI grouph over the PI groupe Shere wae no signifseant difference bebween the IFI and the Cl groups. Julging fran group een performane. the CI group was on the hole mare Eavournd than the other two Instructional gronpa. The edjurted mean for the $C$ qroup wae 4.7 mile that for the IPI greup was 40.68 end that f or the PI group wes 36.43.

### 4.2.3.0. NWAKSTS CF PRELECTCR YRAKADUES

The arbjects" performance on the varicoles for predicting echlevemont in frobibility pont-tent Reading Ablilty. AReltude townerds Mathemetics and Ateltud touerds the Progrem - ure also exemned In ense study. rable 26. page 152 presenks the mans and staxiand doviations of the abjects. scores en the four predlcter varlebles. Sede 17 g pape 153 preaents a sumary of a ontway onalyels of varlepen for the four varieblea and Toble 18. page i54 gives a mumary of the thalues for the comparisen of boys and giris in the atudye

### 4.2.3.1. NHALISI8 OF DIFPRTENCIS IN READING ABILITXI.

An F-ratio of 1.49 revealed no Eignificant differences among the three instructional groups, at the . 05 level of algnificance (table 17). For was there significant difference between boys and girls in the study $(t-0.43, P>.05)$. (table 18).

An examination of table 16 reveale the following:
2. The programmed instruction group had a slightly higher maun ( $\bar{x}=59.8$ ) than either the integrated programed instruction group ( $\bar{Z}$ - 55.5) or the conventional instruction grous ( $\bar{X}$ = 57.1). It should be noted thet the IHI mean was the lowest.

## TAGLE 108

neans amb scamonad osviatzows

```
PON PREDICRCS YARJAOLES
```

| Vericole |  | ProgrenadImotruction |  | Integrated Progratiod Inselfucti on |  |  | Conventsonal Interuction |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | ■ | 8 | 80 | ( | \% | 30 | \% | $\overline{8}$ | Sb |
| Reading Ab111ty |  |  |  |  |  |  |  |  |  |
| Total | 223 | 39. ${ }^{1}$ | 27.70 | 224 | 55. | 20.31 | 103 | 57.2 | 20.34 |
| Boys | 68 | 30.2 | 27.57 | 6 |  | 20.5 |  | 57.4 | 20.8 |
| 62518 | 55 | 99.3 | 28.3 | 55 | 55. | 21.2 |  | 56. ${ }^{\text {c }}$ | 20.8 |
| Matheraties |  |  |  |  |  |  |  |  |  |
| Ablifey |  |  |  |  |  |  |  |  |  |
| Total | 121 | 34.1 | 11.54 | 124 | 36. | 14.56 | 106 | 33.3 | 13.52 |
| Boys | 68 | 34.3 | 11.85 | 66 |  | 25.48 |  | 36.6 | 25.03 |
| Glals | 55 | 13.8 | 21.32 | 58 |  | 23.3 |  | 29.7 | 10.34 |
| Atte Tounce |  |  |  |  |  |  |  |  |  |
| 國the |  |  |  |  |  |  |  |  |  |
| Toeal | 123 | 0.5 | 9.56 | 224 | 7. | 9.18 | 106 | 8.8 | 20.39 |
| Beys | c) | 7.1 | D.86 | C5 | B. | 9. 53 | 50 | 6.4 | 10.20 |
| Girle | 53 | 8.0 | 10.25 | 58 | B | 6.25 | 4. | 8.3 | 10.71 |
| Atte Tounct the |  |  |  |  |  |  |  |  |  |
| Prgares |  |  |  |  |  |  |  |  |  |
| Total | 223 | 1.6 | 6.33 | 824 | 2. | 5.85 | - - | 8.8 | $>$-05 |
| $\begin{aligned} & \text { Boys } \\ & \text { Giris } \end{aligned}$ | 6 | 4.5 | 6.03 | 66 | 2. | 6.00 |  |  |  |
|  | 55 | 2.3 | 6.59 | 58 | 2. | 5.62 |  |  |  |
|  | E | 1.7 | $\cdots<0^{\circ}$ |  | 0.20 | $>$-03 |  |  |  |

$$
=\quad 153
$$

## TADLE 17:

OMEDIAY AMALYSES OF VARINCE FCR MEADYE ARLITY, MATHENATICS NOTLITY AND ATSITUOE TO: ARES HATHEM:ATICS


## TAMLE 18B

TOTAL SCRAES FOR DCY ANO GIRLS ON
EME FOUR PHETICECA VAHIAGLES

| Vart eble | $5 \times 1$ | n | $\stackrel{\square}{x}$ | - | 1 P |
| :---: | :---: | :---: | :---: | :---: | :---: |
| geading | Malo | 192 | 38.8 | 19.6) | $0.03>0.05$ |
| Abslityt | Peane | 868 | 57.0 | 29.3) |  |
| Mathematica | Male | 192 | 35.8 | 14.03) | $2.01^{<.01}$ |
| Absiseys | reale | 168 | 32.1 | 28.92) |  |
| Rtel tudes |  |  |  |  |  |
| Tonneds | Males | 192 | 8.2 | 2.01\% | $0.097^{>.05}$ |
| Mathes | 8-20 | 161 | B. 3 | 9.73) |  |
| isteltude |  |  |  |  |  |
| raveres | Male | 234 | 3.7 | C.02) | $2.54>0.05$ |
| The Progrens | Peone | 183 | 2.3 | 6.008 |  |

2. The mean for the boys in the PI group was higher than any for the eubjects in the other instructional Eroups. It was also higher than that of the girla in the same instructional group.
3. The girla of the XI group had a higher mean than their counterparte in the other instructional groups.
 ABILTTX

The results of the aubjecte' performance in nathomatics ability are sumarised on tables 16 - $18^{\circ}$ There vere no ifgificant differencesamont the three treutment froupa ( $\Gamma=0.236, P>.05$ ). The t-test computed to conpare the overal performance of boys and eirle in the study revealed a significant difforence in eathematical ability in fevour of boys ( $t=2.64, P<.01$ ) 。

When table 16 is examined, the following come to lifhts

1. The boyg in the LPI group had the same mean with their counterpart in the CI group $\bar{Z}=36.6$ ). This mean was however, higher than that for the boys in the RI group
( $\bar{x}-34.3$ ).
2. The CI girls had the lowest mean ( $\bar{K}=29.7$ ).
3. Significant differences existed between PI boy and CI girls ( $t=2.69, \mathrm{P}<.01$ ) the difference favouring the PI boys.
4. There were significant differences between the CI boys and the CI girls ( $t=2.19$; P<-05), CI boys performing significantly better than the CI girls.

### 4.2.3.3. ATALESTS OF DIFY RENU.S IA AFPITUNES

## TOWARDS MNYHENNUTCS

The information on pupils' attitudes towards mathematics urns collected from all pupils in the study. The data was subjected to a one-way analysis of variance for the comparison of the PI, IPI and CI groups and to t-test for the comparison of total boys' and total girls' scores in the study. The results have been summarized in tables $16-18$.

There ware no significant differences among the three instructional groups as is revealed by an Y-ratio of $0.71, P>.05$. Table 18 shows no significant differences between boys' (total) and girls' (total) attitude scores towards mathematics ( $t=0.097, P>.05$ ). However, table

16 reveale that girls of the $8 I$ and the $C I$ groups slightly favoured mathematice nore than the boya in the same treatatnt proupe and also more than the subjecta in the integrated programed instruction group. The lowest preference for matheartics was exhibited by the girls of the IPI group (nean 6.2, $S D=8.25$ ).

### 4.2.3.4. ANALYSIS OR ATTITUDFS TOWANDS THE PKOGRAK

Only the attitudes of tie subjects who leorned by the progran, thit is, those who received individual programmed instruction and those who were taught by the progran and the teacher, were investigated. The attitude scores for the two instructional groups were compared by a t-test. The results of this ststistic are presented in table 16 page 152. A t-value of 1.14 revealed no aignificant differences in attitudes towards the progran between the PI and IPI groups, at the $5 \%$ level or significance, toough the PI group had a slightly higher mean ( $\bar{X}=3.6$ ) than the IFI group $(\bar{X}=2.7)$. This can be interpreted to mean that those pupils who learned individually by the progrem found the programad materials more interesting than these who learned through progran and the teacher. A significant dirference in attitude towards the
progre axiated between boys and offla undergoing the individualized progremod Inotruction (t $=1.76$. $<-05-$ onomalied) with the boye seorking higher ( $\bar{x}=4.5,5-6.03$ ) than the gisio (7 - 2.5, s-6.59). The boye and the girle of the IPI aroup did not show any ulgnffleant differance in attitude (t - 0.28 . $9>0$-03).

When total attitude scores for boys and gifle were compared, no ifgniffcant cifferences were found (t - 1.54, P>.05). Thls tevalue, heweves, was almost algnificant in fevour of boys at the es ievel (enowtalled). On the whole, boye fevoured the progren more than the glels.

## 4.2-4.O. AMAMYSRS GE FETEMIKON REST SCONES

It has boen mentioned in chapter three anction 3.5.4 that a retention test was ndiminigtered to all the gubjects in the stucy el ght mexte after the postmeast adininistration. the items In the retontion test vere the sam as the post-fest itcal. The subjects vere not informed of the impending coleyed postetest. The results of the retention rast sopres vere subjected to - tumpary analyals of covarlance in each of the

Rour cognstive ievelb-inouledge comprohomilo. applicatson and enalyals. STh pestatert secres were used at the coverfate will the retention lest acosen acrved as the criterion. Tables 19 and 20 pages $163-1642$ sumarsen the resulte of cata analyais.
 THE KHONLEDGE COGALZXYE LEYES

There were no ofgnifleant olfferencas in
texching mothoce, sex or in mothodsxsex
interection sut on faretlo of 3.3 for sex vas noarly signsfleant at the .05 level (e5 - 2.346).

The folloring observations are mede fro tedse 20. page 164.

1. Soy undergolng inalvicuallead programaed Inotruetson ignisicantiy croppod in theis rotention ecores therces the meen retention seote for gisis of the seme Inutruetional group zea higher than their postoteat meeno Thare wae alçnsficant difference in retention batwenn the PI boys and PI girle

more moierlala tian the P8 beyso
2. Boys who learned through the progran and the teacher did not show a significant drop in their retention scores, the mean dfference between the post-test and retention test scores being only 2.28.

- On the other hand, the girle" retention scores were higher than their post-test scores, the unadjusted mean difference being 5.64.

3. Both boys and firis undergoing the conventional mode of instruction chowed a drop in their retention scores. The difference between the man scores for the boje was 3.9 while that for gixls was 8.3, an indication that girls had the higheat drop.

Purther analyses wer carried out by t-tests to provide a more concise picture of the statistical group differences on retention. The girls learning through the individualized prosraned instruction performed significantly better than the girls learning by the conventional rethod $\left(M_{2}-K_{2}=8.8, d f=101, t=1.99\right.$ $P<.05$ ). The girls of the PI group also retained signilicantly nore material than the boys of the CI group $\left(\mathrm{H}_{2}-\mathrm{M}_{2}=7.4, \mathrm{t}=1.86, \mathrm{P}<.05\right.$ ono-tailed).

Retention by girls learning by the progran was again significantly hipher thin that oxhibited by boye learning by the samo method. Thin is shown by a t-value of 2.50, I'L.01 for the unadjusted means. The man retention acores for the other groups were not atatistically aignificant.

The foregoing discussion reveals that girls who leerned by the progran individually retained more material than either the boje who received the same instructicn or the boys and girls in the other instructional groups. This may mean that after the instruction and the post-test, the girls in the PI group continued to study the progran at home. Thie reason nay binilarly apply to boya and girls who were taught by the progran and the teacher. The subjects in this treatment group also took the programs hoac with thea and nay have studied then after instruction and subsequent post-testing. No reason can be advanced for the poor retention by the boye of the proeranad inatruction group. Their performance in probability post-test on this coguitive level wa a bit better then thet for the girls of the sane ingtructional group, the mean for the PI boye being 60.14 and thet for the PI girls,
58.59. The poor retention by the CI group can be attributed to the fact that they had no proprans and were not exposed to lesson transcripts after instruction. On the knowledge cogaitive level, therefore, those leaming by progran, whether individually or with teacher gufdance seen to rotain more material than those boing taught by the teacher.

| Source of Variation | Teaching Methods |  | Sex |  |  |  |  |  | Interaction <br> (Method X Sex |  |  | Exror |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Cogni tive - SS } \\ & \text { Level. } \\ & \hline \end{aligned}$ | df | MS | $F$ | Ss | df | MS | F | ss | df | MS | F | ss | + |
| Knowledge 1840.89 | 2 | 920.45 | 1188 | 31681.2 | 2 | 168.2 | 3.34 | 2170.19 | 2 | 1085.10 | 2.16 | 174159.5 |  |
| Comprehension375.53 | 2 | 287.77 | 0.41 | 650.6 | 1 | 650.6 | 1.43 | 99.94 | 2 | 49.97 | 0.11 | 156891.5 |  |
| Application 491.92 | 2 | 245.96 | 0.71 | 16.21 | 1 | 16.2 | 0.05 | 284.06 | 2 | 142.03 | 0.41 | 120305.3 | 34 |
| Analysis 960.56 | 2 | 480.28 | 1.81 | 503.0 | 1 | 503.0 | 1189 | 288.01 | 2 | 144.01 | 0.54 | 92010.9 |  |
| Total scores 600.24 | 2 | 300.12 | 2.71 | 62.51 |  | 62.5 | 0.57 | 251.53 | 2 | 125.76 | 1.14 | 38305. |  |



$$
-165
$$

### 4.2.4.2 ANALYSTS OR BETENFIOL REST-SCOIUS

 ON MHE COHPRIGHEMSION COGHITIVE LEVELA two-way analysis of covariance computed to find out whether ther existed any differences in retention of probability material among the subjects of the three treatnent groups revealed no significant differences. The results of the analysis of data are sumarised in tables 19 and 20.

On an examination of table 20 page 162 it is clear that:

1. the boys of the PI group had an increase of 5.5 marks in their retention scores over their post-test scores while the kirls of the same instructional group dropped by 8.2 points.
2. the subjecta in the IPI group show that they have retained the material learned, the retention scores and post-test scores not being markedly different. The means for the CI group show a similar trend.

All the t-values computed to compare the means of different groups were not statistically signilicant. However, the mean retention acore for boys of the CI group nearly differed
algndfleantly from the mom retentlon seore for the pl giris (t $=1.43,>003$ ) $m_{2}-n_{2}=5.3$ ). The CI boys had a higher retontion mean than the PI giris. On the whole the maen zetention scores for the enys of the CI group yes hloher than that for any single ges group in the study (edjuater man. 53.3, reble 2c).
4.2.4.3. AKALYSTS CF RETEMT:ON TESTOECOREE

GH ADPLACAIJON COONXGXE LEVEL
The P-ratlor enmputed to compare differencea
in setention for cex, teeching methocs and sex by method interection were not slonsfleme. Table 19 papo 163 precents a cuamary of the revalts.

A loek at teble 20 page 162 shows that these vas a drop in retontion for the boye of the PI Frixup. the gifis of the InI group and the giris of the CI group. Som small increase in retentlon scores wes shown by the PI girlm. the IPI beys and the CI boys. On the whola, the CI boya' retention ecores were allghtly migher than for any slogle sex group in the study. The acan retention ecores for the pI boys yas the lowest. There were no signisicant group differemces in ratention.

### 4.2.4.4. ARAUINIS OF RENETTION TAN-BCOIES ON THE ATHLSIS COGNIIVE LEVEL

There were no significant differences among the three treatrent groups, sex or sex $x$ method interaction. Table 19 gives the P-ratios for this cognitive level.

111 the subjects in each of the three treatment groups had drop in their retention ecores (soe table 20). The girls receiving conventional instruction had the greatest drop 11.7 points while the boys recoiving prokramaed instruction had the least drop -0.3. The results indicate that boys who learned probability individually through progranmed materials and boys who were taught by the progral and the teacher retained greater material than the other subjectg. Boys in each treatment group scored relatively higher points in the reteation test than girls in a similar treatment group. On the post-test, girls in each treatment group scored higher than boys in a similar group on the retention teat, the situition was reversed. Thale may be interpreted to mean that girle are not capable of retaining materiul at a higher cogaitive level.

### 4.2.4.5. ANALSIS OF TOIAL RERFMIION YCORES

The total probability retention scores were also mubjected to on analysis of covarianco. with the probability post-test scores usod as the covaminte and the retention scores as the oriterion. The purpose was to find out whethor there were ay differences in retention pang the subjects of tho three treatment groups when total scores were considered. N11 the Famances vere statistically insignificant. The variance Ior teaching mothods approached eignificance at the . 05 level. Table 29 sumarises the results of the analyais of covarisace.

An examination of table 20 reveale the Sollowlag:

1. Boys in the IPI group increased their scores in the retention test.
2. 11 the other aubjects drupped in their retention test Bcores . The giris in the CI group dropped by 5.6 puints followed by boye in the CI eroup by 3.0 points. The boys in the MI group dropped by 2.4 points. The lowest drop wus observed in the MI girls $(0.3)$ and in the IPI girls (0.1).
3. Girls who went through progranaed materials
individually scored higher than bofs who received the sanc inctruction.
4. In the IPI and the CI groupe, boye scored higher than girls of the same group in the retention test.

The foregoing discusaion reveals that the PI firleithe IPI boje and IPI girle retained more material than the bojs of the PI group, the boje of CI group and the girls of the CI Eroup.
4.2.5.0. COKNELATIONAL STUDIES

Variables for the prediction of probability post-test achieverent and retention test scores were also investigited in this study. Por the prediction of probability post-test achievement, Eathematical ability, reading ability attitude toverde mathematics and attitude towarde the progran, were each correlated with the post-test achlevement scores by the Pearson product-noment correlation coefilcieats. The Pearson product-monent correlation coefficients were also computed for pre-test scores and retention test scores, for post-test scores and retention test scores to determine which variable, pretest or post-test Was a better predictor of retention at each of the lour cognitive levele-lanowledge, comprehension
application and analysia.
4.2.5.1. PRENICTION OF FOSTGTPAS $\triangle C H I E V E N A D T$

Table 21 indicates the product-moment correlation coefficiente between each of the prodictor variables and the post-test scores.

## TABLE 21:

## 

## PRELICTOR VAKTAHLES AHD POSTOTESE

> SCURES

$9<-01 \quad+1<03 \quad-03$ (one-ta11al)

The above table reveals that mathematics abllity was a good predictor of achievement for the integrated programed instruction group, where the correlation coeflicients were all significant. For the conventional instruction groupe the correlation coefficients of 0.205 for total scores and 0.290 for boys' scores were 3ignificantly greater than zero at the. 05 level. There was no signilicant correlation between the girls" scores on mathematics ability and their scores on probability post-test in the corventional instruction group. The low correlation coefficients of the PI group are not siznilicant. But a correlation of $0.188, Z=1.554$ for the YI bojs approeched sigaificance at the . 05 level of significance.

The correlation coeflicients between boys" scores on matheantics ability and their scores on probability post-test are relatively higher than those for girls. On this basis, one'can conclude thit nathematics ability is a better predictor of achievenent for boye than for girls.

Reading ability seems to be good predictor of achlevement for the subjects in the integrated
programed instruction group. The correlation coefliciente between probability achievement and readigg ability for the other twb instructional groupa are fairly low. An interesting case is seen in the low nogative correlations for the prograned instruction group, an indication that for this group reading ability is not a good predictor of achievenent. It was observed from table 16 that the mean performance in reading ability test for the profrranmed instruction group was the highest ( $\bar{X}=59.8$ ) which according to earlior IIndings shculd mean that this instructional group should thave performed better in an achievement teat. From the correlational resulte therefore, it seems appropriate to assert that better reading cannot be attributed to higher acilievement in prooability.

## There were low negutive correlations

 between attitude towarde mathematice and probability achievement scores for the subjecte in the programed instruction group. An exanination of table 16 page 152, reveale that girle of the PI group favoured mathenatics nore than any other sex group in the study. This in shown by a relatively higher mean attitude score of 9.50 for the PI girls. Une would expect ahigh attitude score to be ponitively and highly related to higher achievoment. But as it stands here, this was not the case. The low negative correlations exhibited by the subjects in this treatment group may imply that a high positive attitude cannot be attributed to higher achievoaent in probability.

For the IPI group, It was found that signiflcant correlations existed between attitude towarde nathematics scores and probability posttest scores when the total scores were considered ( $5=0.1904, P<.05$ ). The correlation for boje was not signilicant ( $r=0.0954, z=0.769$, $P>-05)$. The correlation for Girls of the ame group was eigrilicant $(5-0.306 ;=2.31$, $P<.05$ )

It was also found that aiguificant correlations existed for the subjects in the conventional ingtruction group at the . 05 level of significance. It can therefore, be interpreted that with the exception of boye in the IPI group, attitude towarde mathematice 1s a good predictor of achievement for the subjects in the UPI and the CI groups. Hence.
for these groups, ilurdoch'e $(6,1968)$ contention that if liking for a subject is great, then learning is enhanced wae supported.

All the correlation coefficients between attitede towarde the progran and probability achievement acores are low and imaignificant (see table 21). It may mean that the subjects did not understand the items in the attituae towarde the progran questionnaire, although each item in the attitude inventory was thoroughly explained to the by their regular teachers. Possibly, a percentage count of the subjects response to each iter would have provided a more precise picture of the nature of the subjects' response to each item.

### 4.2.5.2. PREDICTIOK OF RH:TEITION

Table 22 presenta the Pearson product-moment correlation coefficiente between pre-test probability achievement, post-otest probability achievenant and retantion test scoren, on each of the four cognitive level: - knowledge, comprehension, application and analysis.

## TAFLE 22:

##  POSTーTEFE, AND RETVETOA TEST ON THE FCUR

## COGNITIVE LEVELS

| Cogndelv | Preatest ane | Post-test and |
| :---: | :---: | :---: |
| Level | Retentlen tent | Retentlor test |
|  | Senras | Seoren |
| Total Scores | 0.17538 .05 | C.329 - 8 < .03 |
| Proul lc dge |  | -6.628 : P -01 |
| Comprehension | C.0.4598 P> ${ }^{\text {c5 }}$ | 0.0760: P P 05 |
| Application | 0.06238 P P -05 | 0.133 - $P<.05$ |
| Analyste | -0.076E8 P > 05 | 0.128 啫>.05 |

There existe aignificant positive relationahip between pre-test gcores and retontion scores ( $r=0.176, P<.05$ ) and a significant positive relationship between post-test meores and retention test acores ( $r=0.329, P<.05$ ) when total scores are considered. The relationship between post-test scores and retention test scores is stronger than that between promtest scores and retention test scores.

On the knowledge cognitive level, there is a strong nepative relation between post-test and retention teat scores ( $r=0.628, P<.01$ ), while the relation between pre-tent scores and retention scores is positively low ( $x=0.1298$ ).

The correlation coefficients on the comprehenhion level are vexy low with that betweon post-test and retention test being relatively higher than that between pre-test and retention test scores. This trend also obtains for the applicntion and analyais cognitive levela, namely, the correlation between post-test and retention teat is greater than that between pre-test and retention test scores. From this discussion it is cloar that the post-tent scores are a better
predictor of retention than the initial premtent scores.

Purther product-moment correlation coelficients were computed to provide more information on the predictive nature of the variablea under consideration, namely. pre-test scores and post test scores for the sex groups in each of the three instructional groupa. Table 23 shows the corralations for the instructional groups.

## TABLE 21:

## PRONUCTmOMtiNT COHELAEICMS BLTVLEN

## EREMISTA ROEZ-TETS \&NO RFTMRTIOA

## IEST EP TOTAL SCOKEE



An examination of table 23 reveals the following:

1. Significant positive correlations existed between pro-test scores and retention test acores at the, 05 level for the PI group. The correlation between post-test scores and retention test scores for this same group were not significant at the .05 level of significance. This means that for the Individualized propramed instruction froup pre-test scores were a better predictor for retention than post-test scores.
2. The resulte for the integrated programmed Instruction group show that the correlations between post-tent scores and retention scores were positively hipher than correlations between promtest and retention test scores. Iurther, the correlations between post-test scores and retention test scores were cienificant at the $1 \%$ level while correlations between pre-test and retention test scores verv not eignificant at the 5\% level. The results for thi instructional group indicated that post-test scores are a nore Valid predictive variable for retention than promtert scores.

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3. The correlations between post-test and retention test scores are higher than correlations between pro-test and retention teat scores for the subjects in the conventional instruction group, an indication that post-test scores are a better predictor of retention than pro-test scores.

## CRAPTAR FIVE

## SURMEY. IMPEPPRCTATIONS RECOMTDMDTIONS

## AND COLFCLULIONS

5.0 SUMTART

This study has described the design procedure and analysis of the investigation conducted to deternine the relative offectiveness of three modes of instructions - Programind Instruction, Integrated Programed Instruction and the Conventional mode of instruction and has assessed the relative effectiveness of the three modes of ingtruction upon different sex groups.

Differences among the three instructional
groups in variables such as reading ability, mathonatical ability, attitude toward mathenatics and attitude toward the program have also been examined. Further examinations have been made on the relationship between these predictor variables and achievement in probability post-test; and between pre-test achievement, post-test achievement and retention test.

For data analjais. cae-way analyaic of varimpoe, a two-way analysia of covariance, B-tentr and the Soheffe' test have been used. malyale was done by means of a desk calculetor.

4 one-way analyais of variance was used to sest for differences among the treatment groupa in the lollowing variabless

1. probability pro-test achievenoats
2. reading ability tegts
3. Enthomatical ability teats and
4. attitude toward mathematics.

A two-was analysis of covariance was used So compare subjects" scores in probability postsoot and retention test. The t-testanere nsed to compare the performance between boys and girle In the atudj. The scherfe' test and the special t-sent were computed following eignificant anlysen of Variance and covarinnce respectively to lind ont which pairs of means differed elfonilicentive The Peurson product-moment corralation coefficients were computed to find out which variables were good predictore of chlovomant and retention.
5.1.0. SUICRAKY OF FINDINGS

This section gives a mumary of the Sindinge pertinent to the hypotheses atated on page 8 chapter one on each of the four copnitive levale, and for the two sez-groups. 5.1.1. SUMLIRY OF IFINUINGS OP FOATーTESST ACHTEVEDEHM ON KNOWLUNCE EUEr. TASKS

The hypothesis of no difference among the three instructional groups and between the two Bex Groupl was accepted. But an inspection of the subjects' mean performance revealed thats

1. Girls who learned by the conventional method perforned better on the knowlede sub-teste than boys and girls in the other ingtructional groups.
2. Boys learned better when they received programmed instruction aupplamented by toacher instruction.

## 5.1 .2 SUITRARY OP FINJINGS OP MOSTー\&LCT

 ACUTETEMENT OR THE COMPRNHENEION SUB-TASKSThe hypothesis of no differencen among the treatment groups and between the two sex groups
was supported. Bat different sex groups vere found to interact significantly with different teaching nethods. The analysis of results showed that boys performed relatively better in corprehension tasks when they were taurght by the human teacher than when ther received other instructions. Girls on the other hand leara better when they go through sell inntructional materials.

### 5.1.3. MMLNAT OF HINDING二 OR POSR-TEBT ACBTAEMEIT OA TIE TEPLICAILON COGNISIVE LEVEL

The hypothesis of no differeaces among the three instructional groups ves again accepted. But that of no difference between the two sex groups was rejected. A significant interaction between the two sex groups and the instructional methode was also found.

Girls were found to perfore well when theJ received teacher instruction than when left to studs on their own through the progran. The boys who learned through the progran were relatively auperior in performance to the boys who were taught by the prokram and the teacher. In the corventional ingtruction group, the two sex
groups ver comparable. When the overall
performance of boys and girls wae considered on this level, boye were found to have performed aignificantly botter than girls.
5.1.4. SUITMRI OF FINUINGS OF FOSTーTEST ACHI EVDPUNT CR ANALISIS COGNITIVE LEVEL

The hypothesis of no difference anong the treatment groups was rejected. The integrated prograand instruction and the conventional instruction groups performed better on analysis subtasks than the programed instruction group. On the whole, the performance by the conventional instruction group was superior to that of the other two inotructional groups.

In sumany, the results of this study have shown that in an achievement test, there were no wide differences asong the three inatructional groups on knowledge, comprehension and application subtaskes but that treatment differences did exist on analysis aubtaska.

> and

On knowledge/applicntion subtasks, girls
were found to perform well in the achiovenent test when they were tanght by the teacher, while on
the comprohencion subtaska they learned better through cell-ingtructional matoriais.

Pupile who received teacher instruction performed well on analjsis subtaske. The performace of those pupils who received individualised programmed instruction was the poorest.

It can be said that on higher oognitive levela, pupila who received individumileed instruction perforned poorly while those who had the support of the teacher performed well. Thie argues well for the progran to be supplemented bs teacher instruction. And Banghart ${ }^{\circ}$. (1968) contention that programed materials are moat efiective when used to supplement the classrocm teacher was aupported by the findings of thie studs.

### 5.2. SUPMARI OF ANALYEIS OE FREDICTOR VABTaBIbs

The hypothesis of no difference anong the three instructional groups in the variablea for the prediction of achievement - reading ability. mathematical ability, attitude toward mathematics and attitude towand the progren were all accepted.

The following were, however, revealed from tho subfocts' mean mcorems

1. Un reading ability, the programed instruction group performed better than the other two instructional groups with the programed instruction boys being relatively better readers than all the other subjects in the studj. The programmed instruction girls vore better readers than their counterparte in the other inatructional groupe. The intograted programed instruction group's reading performance was the poorest.
2. Whan the overall performance was compared for boje and girle in the mathematical ability test, boys were lound to be superior to girls.
(a) The IPI boys' mathematical ability scores were comparable to the CI boys' acores.
(b) the IPI boys and CI boys perfoxed better than the CI 8iris. The poor parformance by the CI girls can be interpreted to mean that the CI girls were unable to perform mathomatical computation and reasoning tagks.
3. On the attitude toward mathematics acores
(a) Girls of the PI and CI groups slightly Iavoured anthematics more than the boys In the same treatment groups and also more than the subjecte in the IPI group.
(b) The lowest preference for mathematics was exhibited by the girls of the IPI Broup.
4. Pupils who leamed individually by the progran found the programed matorials mure interesting than those who leamed through the program and the teacher. In the PI group boys favoured the program more than the girle. In the IPI group both boys and gixls equally Paroured the progron.

On the whole, boye were found to lavour the progran more than the girls.

### 5.3. SUIMAKI OF NNALKIS OF RITENIIOA MEBEA

The hypotheais of no difference in retention arone the three instructional eroupe vai supportod In each of the four cognitive levels.

Though there were no differences in retention among the three treatment troups, an examination of the mean gcores revealed the followings

1. On the rowledge anbtacien, the II gixle retainod more menterial than oither the PI boys, tho LII or the CI groups.
2. On the comprabansion eubtaske, tho FI boye ineronsed in their rotention soorom while giris of a aimilar group dropped in thoir retention scores.

On the ubole, the mean reteation scores for boys of the GI gromp was higher than for any alngle saz eroun.
3. Thare man a drop in roteation acores by the boys of the IPI, PI and CI Erroups. A mand inerease in retention was sbown by the gesle of aimilar troatmont eroups.

On the whale, the CI eisle" retentian scores vorw slleat2y hicher than those of the othar sabjects. The moan retention score for the baye wns the lowest.
4. Ca the andysio cubteusta, all the aubjocte dropped in their retantion scores. The CI gisle had the greateat drop and the HI boye the lowont drop. the resulte showed that PI boys and LII boys retainod greater material than the othor aubjects in the etudy. Boye in each tre tment froup soored
relatively hisher then girls of ginilar treatment groupa.
5. When the subjects were compared for their total scores it was found that the IPI boys increased in their retention scores while tho other subjects dropped in their retention scores. The PI girls and the IPI girls had the lowest drop. The bojs of the IPI and the CI groups scored higher than girls. The PI girls scored higher than the YI boys.

On the whole, it can be said that the PI girls, the IPI boys and girls shougd a greater retentive power than boys of the KI and CI groups and the CI girls.

It aeass appropriate to assert here that though the subjects did not show wide differences in the retention test, some small differences did, however, exint. The girla of the PI group seem to have shown a superior retentive power on those tasks that required the recall of specifics. The CI group 's superiority was evident on comprehension eubtaste. It is Snteresting to note that the scores for the


#### Abstract

girls of the three treatment groups were relatively higher than those of the boja in ainilas groups.


When the total scores were considered the retention die rollod in favour of the PI girls, IPI boye and IPI girls. In other words, with the exception of the PI boys, the two programed Groups showed relative superiomity in retention over the CI group. One possible reason that can be advanced for the superiority shown by the progranned group 18 that these two groupa took the prograns home with then at the end of the investigation. It is suspected that thoy may have continued to read the profran. No reason can be found for the poor retention by the PI bojs, particularly when their attitude to programed materials is considered. The boye of this treatment group signilicantly favoured the progran more than the girle of a eimilar group. Hore would possibly have been gained if attitude scores had been correlated with retention test scores.
5.4. SUAMEX OI CORHELATIOUN ANALYSIS 5.4.1. DREDTCRION OF FOST-TEST ACHEEVEGENT

The results of correlational analysis show that methematical ability wal good predictor of achievenent for the boye and girle who roceived programed instruction supplenented with teacher instruction in small groupa. When totel acores were considered, it was found that mathematical ability was a better predictive variable for boye than it was for girle。

Roading ability was also found to be a good predictor of achievement for the IPI group. It is interesting to note that the correlation coefficients for the PI group were all negative and low. This may indicnte that reading ability is not a good predictor of achievement for the subjects who learned through this method.

It was observed from table 16 page 152
t.ant the mean performance in reading ability test for the PI group was the highest, which, according to research literature should imply high performance in the achiovement test.

From the correlational resulte, therefore, it seeas appropriate to assert that for this group the abillty to read cannot be attributed to higher achievenent in probability. It may also mean that comprehension of the reading ability test items may not necessarily be associated with comprehension of progranmod naterials.

Low correlations were recorded between attitude toward mathematic: ecores and post-test achievenent scores for the PI subjects. Inspection of table 16 page 152 revealed that the girle favoured matheratics more than the boys. This was show by a relatively hichor mean attitude score of 9.50 for the PI girls. One would expect a high attitude score to be positively and highly related to higher achievement. But this was not the case. Hence it may be said that a high poaitive attitude towarda a subject cannot be attributed to higher achievement in probability.

With the exception of boye in the IPI group attitule toward mathomatics was a good predictor of achievement for the subjecte in the IPI and the CI groups. For these two groups, Murdoch's (1968) contention that if liking for a subject is great, then learning is enhanced, was supported.

011 the correlation coefficients between attitude towand the progran scores and probability achievement scores were low and inaignificant. No mitable reason can be advanced for this surprise results. The queer result may be interpreted to mean that the attitnde toward the progran was not a good predictor of achievenent for all the three instructional groupa and for the two eex groups.

The boys of the PI erroup favoured the program more than the girle of the same group. Thie lavourable attitude, as susgested by fiustoch Ehould have been followed by high achievenent.

### 5.4.2. PREDICTIUN OF RESENETON

Predictor variables for retention, namely. pro-test achiovement and post-test achievement were examined for total scores and for each of the fonr cognitive levels.

There was a positive relationahip between pre-test and retention scores and a significant positive relationahip between post-test and retention test mcores, the relationship between post-test and retention test scores being etronger than thit between pre-tust and retention test
scores, for total scores.

On the knowledge cognitive level, the relationhip between post-test and retention test was etrongly negative, and aignificant while the relation betweon pro-tent and retention test scores was positively low.

On the comprehension, application and analysis levela, all the correlations were very low. The correlation between post-test and retention teat were rolatively higher than those betwean pre-test and retention test scores.

In sumany, it can be said that post-tont scores are a better predictor of retention than the initial pro-test scores for total scores and for each cognitive level.

Correlation coefficienta were also computed between pre-test. poet-test and retention tegt for total scores, for boys and girls for the three instructional groups.

For the PI group the correlation between pre-test and retention for total scores. for boye and girle were all elgnificant, while those between pest-test and retention tost were not aignilicant - an indication that pre-test scores
were a bettor predictor of retention than post-toat scores.

For the IPI and the CI groups, all the correlatian betwean post-tent mcores and retention test scores wore aignificantly higher than those between pro-test and retention test scores. This mean that post-test scores predict retention more than the initial pretteat scores.

## 

The present atudr has found that the treatzerte and no effect on the aubjects" performance for bnowledge, conprehension and applicition cognitive levels. Por the analysis cognitive level the treatments affected the pupile' scores. The IPI and the CI metbode were superior to the PI method and the CI method Was superior to the IUI method. This means that the CI method is best suited for higher cognitive procesean. The ilndings here have contradicted sone of the resench findings from the west which have attested to the genoral effectiveness of the progran as a mothod of instruction. Tho findings fron the west that programed instruction combined with teacher instruction produce better resulte than individualised programed leaming
have been expperted by the resulte of this study.

The pressent investigator agreen with Banghart's observation that if programed nateriall are well designed and well tested and teachere trainod to compotently supervise prograined learning, then ane can expect a significant achiovenent in favour of prograind materials. The teachern involved in the present study had a brier training period (4 days) in the use of prograns and in the topic taught, i.0. probability. The training period was, however too short to enable the teachere to competently handle the prograns. It should also be noted that this was the firet time guch teachers were exposed to programs. This factor, i.e. lack of competence to handle program may have contribated to the poor performance by the pupils of the programed instruation group. It is therefore recommended that future reseurchers of progranmed learning train -teachers for a longer time in the use of prograns to engure officienoy in utilising programed naterials.

[^5]was not possible to employ the sexvices of teachere of the same grade and to have a single teacher responsible for the three instructional groups. It was however hoped that the training of the teachers in probability would help to remote some teachor varlability with regards to the content of the oubject. But the training of teachern in the content to be taught would not remove toacher intereat in probability or teacher competence to handie the topic. Both variables, nanely teacher interest and teacher competence In the topic could have affected the performance by the aubjects in the programmed instiuction and prosranmed instruction combinod with teacher instruction groups. It in therefore recomended that in any future investigation into the effectironess of programed instruction. teacher interest in the subject and teavher competence to handle the subject should be carefully looked into.

Un occasional visits to experimental schools during the course of instruction, the investigator obsexved that some IPI teachers did not actually integrate with the program. Instead their classen reverted to individualised
prospaned instruction. This is likely to have contributed to the relutively poor performance by the IPI group in comparian to the performance by the CI group. One would expect the IPI group's performance to be much better than either the PI Group's or the CI group's performance if the IPI teachers had really integrated with the proeran. Puture researchery should ensure that IPI teachers reall integrate with the progran to produce better results as suggestod by Baghart and Janieson who emphasize the supportive role of the teacher as being a signilicant lactor in prosrammed learning.

Instruction was conducted durinis the normal mathomatios periode and sll the three instructional Groups had the same amount of learning time. In order to ensure that the subjecter of the throe treatment groupa were in contact with learning materials for approximatelf the same amount of time, the profirans from the PI and IPI groups ware collected at the end of every 2esson. It was observed that the programed instruction group took a relatively shorter time to complete the progran. Inds observation agrees with Meadowaroft's observation. The reaults of his
study showed that although programmed instruction wae not superior to the textbook method, it was nore officient in savins student time.

It is not known how much time the PI group took to complete the whole progran al this was not neasured by the teachers of the PI group as was required. Tise taken by each individual to complete progran is an inportant factor and should therefore be measured and correlated with post-test achievement in futur investigations. It is also necessany to know how much time a teacher spends with each subgroup in the IPI group as the intensity of teacher interaction with each subgroup is likely to affect the performance of the whole class. Hence it is suggested that future researches look into this variable.

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\text { On pages } 108,109 \text { and } 111 \text { it was mentioned that }
$$

the pupils of the FI and the IPI groups did self-tests at the end of each booklet and that the pupils in the CI group were given Class exercises and homework. This means that the CI group had extra work which the other two groups did not have. This may have contributed to the guperior performance by the CI group.

The exercises for the CI group and the sel2-tests for the PI and the IPI ETOupa vero comparable. The post-test sampled the information taught in the progran and the lesson. The post-test, the self-test and the erercises were closely related in most cases. Por this reason it can be said that the criterion test did not favour any one method to the excluaion of the othere. It is therefore the opinion of the investifator that the observed differences were not due to the teat procedures as Pound in Roebuck's studj.

In this studys some PI teachere' apparent negative attitude towards the progran was noted on two occasions, one, when they lailed to recond time taken by each pupil to complete a progran and two, when they raised complaints that the propren was too long and that if thoJ continued using it, they would not finish the syllabus in time. This suggeate that these teachere did not properly utilise the progranmed materials and as has been noted elsowhere, many have contributed to the relatively poor performance by the PI group in comparison to the CI ErOup. Teachere' attitude both towards
the subject and the mothod by which that subject is presented is an important variable that can affect students' performance. It is unlikely that a teacher with low value attachment to eathematice will motivate his pupils into liking the subject. Sinilarly, a teacher who is not eure of a particulur method is not likely to efficiently guide children to learn by that method. It is therefire necessary for future researchors of programed lenraing to examine teachery' attitude towards mathematice and towards the progras as a nothod of instruction, and whetber instruction would produce attitude changes.

Ons of the mest importent varlables in programed learning is a child's reading ability. It is hypothesized that if a child can perfora well in a reading ability test then he can read and underatand programed materials on his own. The recults of this study do not support this hypothesif. The correlation coefficiente for the RI group between reading ability teat scores and post-test scores are negative and low, suggesting inverse relationship. This may imply that the reading ability test used in this study did not use the same terminology used
in the progran and can therefore be regarded as not baing ralid with regards to modern mathonatics prograns like probabilits.

The advantages of proerramed instruction are to be found in the retention test. Retention scores are nore important than immediate pest-test scores. Honce teaching method that produces greater retention power is most ideal. In this study, the three teaching methods. in general, seen to have produced equal Fetentive power. But a close examination of total scorea reveals that the IPI Group Ietainod more material than the other two Eroupa. This helpe to boont the power of the IPI method as a powerful learning tool and supports Dick's contention that the benefits of paired leaming are foun in the rotention of the material and not in the imediate performance.

In this study, iten analysis on the attitude questionnaire was not undertaken. This should be done in future researches to establish the reliability and validity of the questionnaire.

## COHCLUSIOS

The results of this study are linited to the group for which the ztuds was undertakon.

However, it is hoped that these results will be of value to curriculum developers, administrators, primary achool teachers. Rathenatics tutors in the teacher training colleges, and above all, to resenchers in primary nathomatice oducation in Kenya. Further, the fisdinge of this studs should open the way for further resenrch in other areas of procramed leamin which have been mentioned -arlier in this acction.

If the educetional problens mentioned in the introductory section of chapter one are to be overcome, then propramed workshops should be eatablished in the country where teacher interested in the nse of prograns can be trained in the construction and execution of the programes. This will ensure widespread use of the prograres in Renja and will subsequently give then a place in mathemitics education.

During the investigation, sone teachers expressed thoir foars of poseible replacoment by the prograng, should they be found effective. The progrens should not be seen as an attempt to replace the human teacher, but should be viewod
as a powerful and effective aid for the teacher. As aucgested by Imwless, the nse of prograne
wil release the teacher fron the rigid pattern of class teaching.

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## APPGNDIX 4

## PROGRAMYED INSTRUORION

## PROBABIITTTI

## IMTRODUCTION

The material presented to you here is in the form of program for self-instruction. The subject natter covered in this progran has been broken into items or frames which permit you to learn efficiently by studying and answering each step or frame separately.

The nost effective way to study a program for self-instruction is to read and study each frame carefully, you should study definitions and formulas thoroughly as you go along so that jou will be able to acquire new information step by step.

After you have studied a question frame, write out jour answer fully on a separate piece of paper, then icompare your answer with the answer given at the back of the page.

The material will be arranged in this manners-

1. Look in jour multiplication table.

Can you lind an "answer" to

2. Look at the number line below.


Into how many smaller segments have we
divided the unit segment (the length from
( to 1)?
3. Refer to frame 2.

What National number is shown by the length
of the segment from.
(a) 0 to 1 ?
(b) 0 to B ?
(c) 0 to C ?
(d) 0 to 1 ?

Answers.

1. $2 / / ; 1 / \hbar ; 1 \frac{1}{3} ; \quad 2.4$ smaller segments $1 \frac{3}{5} ; 1 \frac{8}{9} ; 1 \frac{2}{7}$
2. (a) $x$
(b) $1 /$
(c)
(d) 1.

Iou are to write down your answer in the blank of each frame. Then conpare jour answer with the answer given at the bottom of each page. If jou do not get a question at the end of a frame correct, read again the frame corresponding to the question.

At the end of each section there is a short test intended as a self-test. The answerg are given following this test. If you do not get the questions in the self-test correct, read the frames again until jou understand them well to enable you to do the self-tests. If, after rereading the frames jou still cannot understand ask jour teacher to help you.

## Why study probabilitr

Probability, is an important branch of matberatics. It is used in making decisions in military operations, scientific research, design and quality control of manufactured products; insurace. calculations, governmental operations, etc. It is also important in all gares of chance.

When learning about probability, you are learning about a very important branch of mathematics.

This unit is divided into three sections. Section one deals with ideas about chance, section two is on Axperiments in Probability and section three is about Finding Probability.

1. Thincing about chance.

## Materials.

Materials needed for this unit include dice, coins - 5-cent piece, 10-cent piece and 50-cent pieces marbles and spinners, - .

Terns to be learned.
Likely, unlikely, chance, probably, certain, uncertain, probability, fair, unfair.

## Furposes

To stimulate pupils to think more objectively about chance events. Ihrough participation, discussion, and sometimes, demonstrations by the teacher, pupils will have opportunities to test their intuition regarding the results of some activities involving chance and to make guesses, estimates, and prodictions about such results.

Sugiested time:- 5 to 6 lessons.
Introduction:
You probably have heard or made statements 14ke:

1. It is more likely that I shall go to see my uncle during the holidays.
2. Chances are good that my father will buy me a shirt at the end of this month.
3. Kama and Barasa have equal chances to win.
4. I am almost certain that I can come to your house after school.

These sentences are alike in one way. They have words and ideas which are used in mathematics. These words and ideas are used in a part of mathematics called probability. In probability we are interested in thing which happen by chance. By using mathematics we can often estimate quite accurately what will probably happen.

1. Answer the following questions:
a) Which footbal club will win the East and Central Africa Club Championships cup sext year? $\qquad$
b) Will all the members of your class be in school next Monday? $\qquad$
2. The questions in frame 1 are chance events. Can you be certain of their answers?
3. Some thing are more likely to happen than others,
a) Which is more likely, that one of the pupils in this class will be absent or that the mathematics teacher in this class will be absent?

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\text { - } \quad 220
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b) Which is sore likely, that you will have ugli for breakfast or that you will have ural for lunch?
4. Some things are more likely to happen than not.
a) In Klsure in July, is it more likely than not that it willxrain at noon? $\qquad$
b) Is it more likely than not that you can find the sur of 324 and $465 ?$ $\qquad$
5. some things are certain and sone things are impossible. Write $C$ if an event is certain or I $1 f$ the event is impossible.
i) A man can live without water for three months $\qquad$
ii) Barasa's dog can write his first and last names in swahili $\qquad$
iii) All new cars from China this fear will use water for fuel. $\qquad$
iv) Tomorrow, today, will be yesterday. $\qquad$
newborns
4
(a) Not likely,
(b) More likely, $324 * 465=789$
5. (i) I (ii) I (iii) I
(iv) I
6. Our ideas about chance might be classified as certain, uncertain g or impossible,

In the following sentences, write $C$, $U$, or I for certain uncertain, or impossible.
(a) It is ___ that the sun will set in the east.
(b) It is ___ that a river flows downhill.
(c) It is ___ that we will see the sun tomorrow.
(d) It is ___ that a river flows uphill.
(e) It is ___ that I will not sleep at all this week
(f) It is ___ that a river is deep today than yesterday.
7. When we say a teacher gives a test on Friday, it does not mean we are sure he is going to give one this Friday. We can use numbers to tell how likely it is that he will give a test this Friday. Mrs. Obunga gave a test on 3 Fridays out of every 4 last year.

Mr. Ogoti gave a test on 7 Fridays out of every 8 last year.

Mrs. Oriya gave a test on 2 out of every 3 Fridays last year.

Mrs. Oyer gave a test on 20 out of every 21 Fridays last year.
Who is the mast likely to give a test on Friday? $\qquad$ Who is the least likely to give a test on Friday? $\qquad$

## Answers:

6. (a) I
(b) c
(c) U
(d) I (e) I
(I) U.
7. Mrs. Oyor, Mr. Ogot.
8. For Mrs. Obunga's 3 out 4, we write $火$. For Mrs. Ogoti's 7 out of 8 , we write $\frac{7}{8}$. For Mrs. Okija's 2 out of 3 , we write $\qquad$
For Mrs. Oyor's 20 out of 21, we write $\qquad$
9. Write the outcomes in frame 8 as equivalent fractions. $\qquad$ , $\qquad$ , $\qquad$ , $\qquad$ -
10. 

On the left is a picture of a die.

(a) How many faces has the die? $\qquad$
(b) List the number of dots on the remaining faces $\qquad$
11. If the die on frame 10 is tossed once, there are six possible outcomes $\quad$,
$\qquad$
,

Answers:
8. $\frac{2}{3} \frac{20}{21}$
9. $\frac{126}{168}, \frac{147}{168}, \frac{112}{168}, \frac{160}{168}$.
10. (a) 6 (b) 1, 2, 4,
11. 1, 2, 3, 4, 5, 6.
12. If a die is tossed, the face that is on top is the one that counts. For example, in frame 10, the face with 3 dots shows up. So this is the face that we consider. If we were playing a game with this die, we would consider the result as a score of 3 .
13. If the die in frame 10 is tossed once, how many times are the following numbers likely to show on the top face?

14. If we toss a die once, are there equal chances that a number on any of the six faces will show up? $\qquad$
15. If events have equal chances of occuring, we soy that they are equally likely. If you were playing a game with a friend and each one of you had an equal chance of winning, we would say that the game was fair. But if one of you had more chances of winning, we would say that the game wo

Answers:
12. No answer is required
13. Once; once; once; once; once; once;
14. Yes.
15. Unfair.
16. Iou are to plas agane with jour Iriend. The gane is "Toss a die once and see who wins." In this game jou win if I shows up. The other wins if 3 shows up. In order to decide whether the gase is fair or unfair, we first list all the possible outcomes of the game. These outcomes are
$\qquad$ , $\qquad$ , $\qquad$ , $\qquad$ , $\qquad$ , $\qquad$
17. After we have listed all the possible outcomes of a single toss of a die, we then find the number of times I is likely to show out of the six possible occurrences. We also find the number of times 3 is likely to show on the top lace of the die.

We see that I is likely to show on the top face once and 3 is also likely to show up on the face once We say that these events, I showing up and 3 showing up are likely. And the two plajers have equal chances of winning the game. Therefore the game is $\qquad$

Answers:
16. 1, 2, 3, 4, 5, 6.
17. Equallj; Iair.
18. In the fane "Toss one die and see who wins", you win if an odd number shows up. The other player wins if an even number shows up. Write dow the set of odd numbers and the set of even numbers that are likely to show up.
(a) (odd numbers ) = ( $\qquad$
$\qquad$

(b) (even numbers) = ( $\qquad$ , —,

(c) Are these events equally likely? $\qquad$
(d) Is the game fair or unfair? $\qquad$
19. In the game "Toss one die and see who wins", you win if 3 is up. The other player wins if a number greater than 3 is up.

List the outcomes for each player.
(a) Outcomes for first player $\qquad$
(b) Outcomes for second player $\qquad$ , $\qquad$ ——.
(c) Are these outcomes equally likely? $\qquad$
(d) Is the game fair or unfair $\qquad$ -

Answers:
18. (a) (odd numbers) $=(1,3,5$.
(b) (even numbers)= (2, 4, 6.)
(c) Ies
(d) Fair.
19. (a) 3 (b) 4, 5, 6. (c) No
(d) Unfair.
20. If one die is tossed, there are 6 possible outcomes. If two dice are tossed, there are 36 possible outcomes. These are
$(1,1),(1,2),(1,3),(1,4),(1,5),(1,6)$
$(2,1),(2,2),(2,3),(2,4),(2,5),(2,6)$
$(3,1),(3,2),(3,3),(3,4),(3,5),(3,6)$


21. In frame 20 the first number in the ordered pair refers to the outcome on the first die, while the second number refers to the outcome on the second die. Thus in the outcome $(1,3), 1$ is the number that shows up on the first die and 3 is the number that shows up on the second die.
22. You are to play a game with your friend. The game is, "Toss two dice together". One die is white, the other die is green. In this game, you will win if 1 is on each die, that is you win if the outcome is ( 1,1 ).

## Answers:

20. $\left(\begin{array}{l}4,1),(4,2),(4,3),(4,4),(4,5),(4,6) \\ 5,1),(5,2),(5,3),(5,4),(5,5),(5,6)\end{array}\right.$
$(6,1),(6,2),(6,3),(6,4),(6,5),(6,6)$
21. No answer is required.

The other player wins if 5 is on each die. That is he wins if the outcome is $(5,5)$.
(a) Outcome for first player $\qquad$
(b) Outcome for second player $\qquad$
(c) Are these outcomes equally likely? $\qquad$
(d) Is the game fair or unfair? $\qquad$
23. In the game of frame 22, you win if there is an even number on the white die. The other player wing otherwise.
(a) Outcomes for the first player are

(b) Outcomes for the second player are:
$(1,1),(1,2),(1,3),(1,4),(1,5),(1,6)$
$(3,1),(\ldots),(\ldots),(\ldots),(\ldots),(\ldots)$


## Answers:

22. $(5,5)$
(a) $(1,1)$,
(b) $(5,5)$
(c) Yes
(d) fair, because each player has one chance out of 36 possible chances.
23. (a) $(4,2),(4,3),(4,4),(4,5),(4,6)$
$(6,1),(6,2),(6,4),(6,5),(6,6)$
(b) $(3,2),(3,3),(3,4),(3,5),(3,6)$
$(5,1),(5,2),(5,3),(5,4),(5,5),(5,6)$.
24.(a) Are the outcomes in frame 23 equally likely? _
(b) Is the game in frame 20 fair or unfair? $\qquad$
24. In the game in frame 22, you win if 6 is on the white die, and he wins if 4 is on the green die.
(a) Outcomes for the first player are

$$
(6,1),(ـ),\left(ـ_{-}\right),\left(ـ_{1}\right),
$$

(b) Outcomes for the second player are

$$
(1,4),(,),(,),(,),(,)
$$

(c) When will the two players tie?
$\qquad$
26. (a) Are the outcomes for the players in frame 25 equally likely? $\qquad$
(b) Is the game in frame 25 fair or unfair?

## Answers

24. Yes Because each player has 18 chances out of 36 possible outcomes.
(b) The game is fair.
25. (a) $(6,1)(6,2),(6,3),(6,5),(6,6)$
(b) $(1,4),(2,4),(3,4),(4,4),(4,5)$
(c) There will be a tia if the outcome for each is ( 6,4 ).
26. (a) Yes, since each player has 5 chances of winning.
(b) The game is fair.
27. Refer to the game in frame 22.

You win if $I$ is on each die. He wins if one die has 1 and the other die has 2.
(a) Outcome (s) for the first player
(b) Outcomes for the second player (. . ). ( . .)
(c) Are these outcomes equally likely?
(d) Is this game fair or unfair?
28. Refer to frame 22.

You win if the number on the white die is greater
than the number on the green die. He wins otherwise.
(a) Outcomes for first player are


Answers
27.
(a) $(1,1)$,
(b) $(1,2),(2,1)$
(c) No
(d) Unfair
28.
(a) $(2,1),(3,1),(3,2),(4,1),(4,2),(4,3)$
$(5,1),(5,2),(5,3),(5,4)$
$(6,1),(6,2),(6,3),(6,4),(6,5)$.
28. (b) Outcomes for second player are:

$$
\begin{aligned}
(1,1),(1,2), & (1,3),(1,4),(1,5),(1,6) \\
(2,2), & (2,3),(2),(,,),(-) \\
& (3,3),(\ldots),(,),(,) \\
& (\ldots),(\ldots) \\
& (\ldots,)
\end{aligned}
$$

29. (a) Are the outcomes of frame 28 equally likely?
(b) Is the game fair or unfair? $\qquad$
30. In this game one die is tossed twice. You win if the number the second time is greater than the number the first time. Otherwise he wins.

## Answer:

28. 

(b) $(1,1),(1,2),(1,3),(1,4),(1,5),(1,6)$ $(2,2),(2,3),(2,4),(2,5),(2,6)$
$(3,3),(3,4),(3,5),(3,6)$
$(4,4),(4,5),(4,6)$
$(5,5),(6,6)$
29. (a) No. Player 1 has 15 out of 36 chances of winning. Player 2 has 21 chances of winning. The outcomes are therefore, not equally likely.
(b) The game is unfair.
30. (i) List the outcomes for the first player.

(ii) List the outcomes for the second player.

$(2,1)(\square)$


Answers
30. (1) $(1,2),(1,3),(1,4),(1,5),(1,6)$

$$
(2,3),(2,4),(2,5),(2,6)
$$

$$
(3,4),(3,5),(3,6)
$$

$$
(4,5),(4,6)
$$

$$
(5,6)
$$

(ii) $(1,1)$
$(2,1),(2,2)$
$(3,1),(3,2),(3,3)$
$(4,1),(4,2),(4,3),(4,4)$
$(5,1),(5,2),(5,3),(5,4),(5,5)$
$(6,1),(6,2),(6,3),(6,4),(6,5),(6,6)$.
31. (i) Are the outcomes in frame 30 equally likely? $\qquad$
(ii) Is the game in frame 30 fair or unfair?
32. For the game in frame 30 you win if the number each time is even. He wins if the number each time is odd.
(i) List the outcomes for the first player.

$$
\begin{aligned}
& (2-),(2,4),(\ldots),(\ldots),(\ldots) \\
& (\ldots),\left(\_\right),\left(\_\right),(ـ)
\end{aligned}
$$

(ii) List the outcomes for the second player.

33. (i) Are the outcomes in frame 32 equally likely?
(ii) Is the game in frame 32 fair or unfair?

Answers:
31. (i) No. Player 1 has 15 chances while player 2 has 21 chances.
(ii) The game is unfair.
32.

$$
\text { (1) } \begin{aligned}
& (2,2),(2,4),(2,6) \\
& (4,2),(4,4),(4,6) \\
& (6,2),(6,4),(6,6)
\end{aligned}
$$

(ii) $(1,1),(1,3),(1,5)$ $(3,1),(3,3),(3,5)$
$(5,1),(5,3),(5,5)$
33. (i) Yes
(ii) The game is fair.
34. The word outcomes is often used in talking about probability. People often ask, "How did the Football game cone out?" or they right say "what was the outcome of the football game?". In probability, when we talk about the outcomes of an activity, we mean all the things that can happen (all the possibilities). For a football game, for example, there are three possibilities or outcomes. Your team will win; your team will
$\qquad$ or there will be a $\qquad$
35. In the game, "Toss a die once and see who wins," the first player won if an odd number showed up and the second player won if an even number showed up. We can make a list of outcomes and see whether or not the outcomes are equally likely. For instance for the first player, the outcomes were, ( $1, \ldots, \ldots$ ). For the second player the outcomes were (_, _, _). Since there are elements in each set, we say that the outcomes are ___ likely.

Answers:
34. Lose
a draw or a tie.
35. Outcomes for first player: 1, 3, 5. Outcomes for second players, 4, 6. 3 elements equally.
36. You are to play a game with your friend, The game is Toss a coin once and see who wins."

You win if a tail shows up, Your friend wins if a head show up.
(a) How many outcomes are there for the game
(b) List the outcomes $\qquad$
37. Refer to frame 36. Write $T$ if the following statement is true, if it is false, write $F$.
(a) My friend is more likely to win $\qquad$
(b) I stand a better chance of winning $\qquad$
(c) We are both equally likely to win
38. (a) What are the outcomes when you toss a die. Remember a die has six faces, and any one of these faces may be up. The outcomes are 1, 2, 3, -, -. -.
(b) Are these outcomes equally likely? $\qquad$
(c) Are there just six outcomes when you toss two dice?
(d) How many outcomes are there when you toss two dice?

Answers:
36. (a) 2 outcomes altogether
(b) Head; Tail
37. (a) F
(b) F
(c) T.
38. (a) 1, 2, 3, 4, 5, 6.
(b) Yes
(c) No
(d) 36 outcomes.
39. To make a list of the outcomes, you make a table. The left side of the table shows the number of dots on the white die. The top of the table shows the number of dots on the green die.

Use a number pair for each outcome. The first number is the outcome on the white die, and the second number is the outcome on the green die. If the white die has 1 up , the green die might have 1 also. This is shown as ( 1,1 ).

Finish the table below. Write a number pair for each outcome.

(a) How many different number pairs are shown in the table $\qquad$
(b) How many outcomes are there for tossing two dice $\qquad$
(c) Are all these outcomes equally likely? $\qquad$

Answer:
39.

| 1 | 2 | 3 | 4 | 5 | 6 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | $(1,1)$ | $(1,2)$ | $(1,3)$ | $(1,4)$ | $(1,5)$ | $(1,6))$ |
| 2 | $(2,1)$ | $(2,2)$ | $(2,3)$ | $(2,4)$ | $(2,5)$ | $(2,6)$ |
| 3 | $(3,1)$ | $(3,2)$ | $(3,3)$ | $(3,4)$ | $(3,5)$ | $(5,6)$ |
| 4 | $(4,1)$ | $(4,2)$ | $(4,3)$ | $(4,4)$ | $(4,5)$ | $(4,6)$ |
| 5 | $(5,1)$ | $(5,2)$ | $(5,3)$ | $(5,4)$ | $(5,5)$ | $(5,5)$ |
| 6 | $(6,1)$ | $(6,2)$ | $(6,3)$ | $(6,4)$ | $(6,5)$ | $(6,6))$ |

(a) 36 different number pairs shown on the table.
(b) There are 36 outcomes for tossing two dice.
(c) Ies.
40. The spinner on the right is half white and half red. If Jour spin the pointer, what are the outcomes? (Assume that the pointer does not stop on the boundary. If the pointer stops on the boundary, do
 not count it as a spin.
(a) The outcomes are $\qquad$ and $\qquad$ .
(b) Are these outcomes equally likely? $\qquad$ *
41.
(a) What are the outcomes in the spinner below? __ and $\qquad$
(b) Are they equally likely? $\qquad$ The rule is you win if the pointer stops on $Y_{;}$you lose if it stops on $x$. Do you want to play? $\qquad$ Why? $\qquad$

## Answers:

40. (a) The outcomes are Red and White.
(b) Yes.
41. (a) X and I.
(b) No. The pointer of the spinner is likely to stop on $X$ most of the time (in fact it will stop on $X X$ of the time and on $Y K$ of the time).
(c) No.
(d) Because I may lose most of the time.

## SEIP-TEST: I

For each game a rule is given that tells who wins. If neither player wins, the game is a tie. Try to tell whether each came is fair and, if not who is more likely to win. If the game is fair, write "P" in the blank. If you are more likely to win, write "I". If the other player is more likely to win, write "O".

1. Use one die.
(a) Iou win if 1 is up. The other player wins 1: 3 is up. $\qquad$
(b) Iou win if an odd number is up. The other player wins if an even number is up. $\qquad$
(c) You win if 3 is up. The other player wins if a number greater than 3 is up. $\qquad$
2. For these games, if 1 is up, call it Result 1. If either 2 or 4 is up, call it Result 2 .

If 3, 5, or 6 is up, call it Result 3.
(a) You win on Result 3. The other player wins on Result 1. $\qquad$
(b) You win on Result 3, and he wins on any Result less than 3 . $\qquad$
(c) Iou win on an even numbered Result, and he wins otherwise. $\qquad$

Answers to self-test $1:$

1. (a) $F$
(b) $P$
(c) 0
2. (a) $Y$
(b) $F$
(c) 0 .
3. Use two dice, one white and one greer.

Toss them together.
(a) You win if 1 is on each die. The other player wins if 5 is on each die. $\qquad$
(b) You win if there is an even number on the white die. The other player wins otherwise.
(c) Iou win if 6 is on the white die, and he wins if 4 is on the green dice. $\qquad$
(d) You win if 1 is on each die. He wins if one die has 1 and the other has 2. $\qquad$
(e) Iou win if the number on the white die is greater than the number on the green die. He wins otherwise. $\qquad$
4. Use one die, and throw it two times for each game.
(a) You win if the number the second time is greater than the number the first time. Otherwise, he wins. $\qquad$
(b) You win if the number each time is even. He wins if the number each time is odd. $\qquad$
5. What are the outcomes when you toss a die? It has six faces, and any one of these faces may be up. The outcomes are 1, 2, 3, _, _, __.

Answers:
3. (a) $F$ (b) $F$ (c) $F$ (It is also possible for
(d) 0 (e) 0
4. (a) 0 (b) $F$
5. 1, 2, 3, 4, 5, 6.

$$
-\quad 240
$$

## SECTIORI II

## EXPERTMLNTS IN PROBABILITY

Objective: To help the pupils with the techniques for gathering, tabulating, graphing and interpreting data which they generate by tossing a coin, tossing a die and drawing marbles.

The ideas gained from activities should sharpen children's intuition about chance events iy analyzing the results of a large number of trials.

Vocabulary:- Tabulate, horizontal, vertical,tally. Materialsi- Spinner, coin: 5-centqxpiece and 50-cent piece; dice, marbles.

Suggested Time:- 6 to 8 lessons.
A. Tossing a Die
42. If jou toss a die once, jou have six outcomes. 1, 2, 3, 4, 5, 6. If you toss the die once you may get any of these outcomes. If you toss the die six times, do you think you will get each of the outcomes exactly once? $\qquad$

## Answer:

42. No.
43. Mana tossed a die 20 times and recorded her outcomes in the following table.


Iou now toss a die 60 times and make record of the member of dots on the top face. Record jour results in a table such as the one shown above.
44. Uso jour renulta of Irate 43 to answer the following questions:-
(a) How many $1^{\prime}$ © did you get? $\qquad$
(b) How many $3^{\prime}$ s did you get?
(a) Did you got each outcome about the same number of times? $\qquad$
45. Toss a die 100 times. Keep a record of your results in the table below.

| No.01 | No.01 |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 2.5 | 2.5 | N0.01 <br> 3.5 | NO. OI <br> 4.5 | NO.01 <br> 5.5 | NO.01 <br> 6.5 |
| Tally |  |  |  |  |  |

(a) Did you get each outcome about the same number of times? $\qquad$
(b) Does your experiment make you think that in the long run you are likely to get each outcome 1 time in $6 ?$
46. In frame 43, you tossed a die 60 times and recorded your results in a table. Use these

47. Toss a die 10 times and record your results in the following table.

| No. of | No.01 | No.0f | No.0f | No. of | No. of | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| No. of |  |  |  |  |  |  |
| Tosses |  |  |  |  |  |  |

48. (a) from your totals in frame 47 which face of the die was up the most? $\qquad$
(b) Are any two or more totals the same? $\qquad$
(c) Would you expect that on 10 tosses, each number would come up at least once?
If we tossed a die 1000 times, could we be sure that every number would come up at least once? $\qquad$
49. (c) Yes
50. No.
51. If two dice are tossed at the same time each of the number 1, 2, 3, 5, 6 are equally likely to show up on the top face of the first die and each of the number 1, 2, 3, 5, 6 are equally likely to show up on the second die.

We can write the scores on the top faces of two dice using ordered pairs as follows:-
$(1,1),(1,2),(1,3),(2,6)$, etc.
The first number represents a number on the top face of the first die and the second on the second die.
(a) List all the possible outcomes in a single throw of two dice.
(b) How many possible outcomes are there? $\qquad$

## Answer:

50. (a) $(1,1),(1,2),(1,3),(1,4),(1,5)(1,6)$ $(2,1),(2,2),(2,3),(2,4),(2,5)(2,6)$ $(3,1),(3,2),(3,3),(3,4),(3,5),(3,6)$ $(4,1),(4,2),(4,3),(4,4),(4,5),(4,6)$ $(5,1),(5,2),(5,3),(5,4),(5,5),(5,6)$ $(6,1),(6,2),(6,3),(6,4),(6,5),(6,6)$.
(b) 36.
51. The best way to try and answer the question in Ira 50 is to use a graph. Thus


Complete this graph.

Answers
51.

$$
\begin{aligned}
& \begin{array}{l}
6 \\
5
\end{array}(2,6)(2,6)(3,6)(4,6)(5,6)(6,6) \\
& \begin{array}{l}
10.0 n_{4}^{5} \cdot(1,5)(2,5)(3,5)(4,5)(5,5)(6,5) \\
156)(2,4)(3,4)(4,4)(5,4)(6,4)
\end{array} \\
& \text { die }
\end{aligned}
$$

B. Tossing a Coin
52. Maria tossed a coin 22 times and recorded her results in a table below:-

|  | No. of <br> heads up | No. of <br> tails up | Total No. <br> of Tosses |
| :---: | :---: | :---: | :---: |
| Tally | Hf 1111 | HIt 2131 Ill |  |
| Total | 9 | 13 | 22 |

(a) How many times did she get a head? $\qquad$
(b) How many times did she get a tail? $\qquad$ Are her outcomes equally likely? $\qquad$
(b) How many times did she expect to get a head? $\qquad$ a tail? $\qquad$
53. Toss a coin 100 times. Keep a record of the results in table below:-

|  | No. of <br> heads | No. of <br> tails | Total No. <br> of Tosses |
| :--- | :--- | :--- | :--- |
| Tall |  |  |  |
| Total |  |  |  |

1. Did you expect to get the "heads" about half the times? $\qquad$
2. Did you get "heads" more .than 40 times ?
3. Did you get about as many "heads" as "tails"?

## Answers:

52. (a) 9 times; 13 times; No. (b) 11 times; 11 tim
53. (i) Yes.
54. If you toss a coin once,
(a) How many times would you expect a head to show . up? $\qquad$
(b) How many times would you expect a tail to show up? $\qquad$
(c) Are these outcomes equally likely? $\qquad$
55. If you toss a coin once, you would expect a head to come down once and a tail to come dow once. If you toss a coin 10 times
(a) How many times would you expect a head to come down? $\qquad$
(b) How many tines would you expect a tail to come down? $\qquad$
56. Toss a coin 200 times and keep a record in a table such as the one shown on frame 52.
(a) How many times did you get a head? $\qquad$
(b) How many times did you get a tail? $\qquad$
(c) How many times do you expect to get a head? $\qquad$
(d) How many times do you expect to get a tail? $\qquad$

Answers:
54. (a) once
(b) Once
(c) Yes.
55. (a) 5 times
(b) 5 times
56. (c) 100 times
(d) 100 times
57. Hefer to frame 56.

Is the number of times the "heads" showed up when you tossed a coin 200 times closer to the number of times you would expect "heads" to show up when a coin is tossed 200 times? $\qquad$
58. Take two coins, a 10 -cent coin and a 5-cent coin. Toss them together. Record your result in a table below:-

|  | No. of <br> heads up | No.of <br> tails up | Total No. <br> of Tosses |
| :---: | :---: | :---: | :---: |
| 10-cent <br> coin |  |  |  |
| $5-$ cent <br> coin |  |  |  |

Repeat this experiment 40 times.
(a) How many times do you get two heads? $\qquad$
(b) How many times do you get two tails? $\qquad$
(c) How many times do you get a head and tail?
(d) Do you think you would get a head and a tail almost 2 times as you would get 2 heads or 2 tails?

## Answers:

57. Yes.
58. Yes.
59. When two coin are tossed, a 10-cont piece and a 5-cont ploce, they can fall in one of the the following mays shown in
the table below-


Complete this table.
60. The table in frame 59 can be draw a ans

$$
10 \text { - cent piece }
$$


Complete the table.
anaveres
59.

| Ten-cent piece | Pive-cont piece |
| :---: | :---: |
| Head | Head |
| Head | Tail |
| Tail | Hoad |
| Tail | Tall |

60. 


61. Toss. 3 coins, a 5-cent coin, a lo-cent coin and a 50-cent coin. Record jour results in a


How many times de you get
(a) 3 heads $\qquad$
(b) 3 tails $\qquad$
(c) a head and a tail.
62. If you toss 3 coins they can fall in 8 different ways. Complete the table below.

50-cent piece 10-cent piece 5-cent piece

| Head | Head | Head |
| :---: | :---: | :---: |
| Head | Head | Tail |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |

## Answers:

62. 

50-cent piece 10-cent piece 5-cent piece

| Head | Head | Head |
| :--- | :--- | :--- |
| Head | Head | Tail |
| Head | Tail | Head |
| Head | Tail | Tail |
| Tail | Head | Head |
| Tail | Head | Tail |
| Tail | Tail | Head |
|  | Tail | Tail |

63. All the outcomes from a toss of three coins can also be shown in a table such as this


Complete this table.
(a) How many times are wo likely to get 3 heads? $\qquad$
(b) 3 tails $\qquad$
(b) How many times are we likely to get two heads and one tail? $\qquad$
(c) How many times are we likely to get one head and 2 tails?
64. If you toss one coin it can fall in one of two different ways. If you toss two coins they can fall in one of four different ways. If you toss three coins they can fall in one of $\qquad$ different ways.

Complete the above pa therm and use it to decide in how many different ways you think four coins fall. $\qquad$
63.

(a) One time; one time
(b) 3 times
(c) 3 times
64. 8 different ways; that is $2 \times 2 \mathrm{X} 2=2^{3}=8$ 4 coins can fall in 16 different ways. That is $2^{4}=2 \times 2 \times 2 \times 2=16$.
65. If we toss 2 coins we may record the outcomes as is shown in the table belowi-

| $2 H, O T$ | $I H, I T$ | OI, 2T |
| :---: | :---: | :---: |
| HH | HT | TTS |
| No. of \| <br> OUtconer 1 | - | 1 |

66. Make able as the one in frane 65 for 3 tosses of a coin.

## Answers:

65. 

|  | $2 H, O T$ | IH,IT | $O H, 2 T$ |
| :---: | :---: | :---: | :---: |
|  |  | HH: | TH |
|  |  |  |  |
| No. of <br> OUtcomer | 1 | 2 | 1 |

66. 

|  | 3H,OT | 2H,IT | IH,2T | OH, 3 T |
| :---: | :---: | :---: | :---: | :---: |
|  | H\% | H8T | HIT | TITT |
|  |  | HTH | THET |  |
|  |  | THE | TRH |  |
| No. of outcomes | 1 | 3 | 3 | 1 |

67. Complete the table below for 4 tosses of a coin.


Answer:

68. We can oxganize our resulte from 65,66
and 67 in a triangular form. This triangle


Complete the row for the 4th toss.
69. Look at the pattern in the triangle on frame 68. Complete the 5 th and the 6 th rows ( 5 and 6 tosses of a coin) without making a table.
70. I tossed a coin 40 times and counted 18 heads. Is this less or more than you would have expected?

Answers:

| 66. | 4th toss | $\begin{gathered} 1 \\ 4 \mathrm{H}, 0 \mathrm{OT} \end{gathered}$ | $\begin{gathered} 4 \\ 3 H, I T \end{gathered}$ | $\begin{gathered} 6 \\ 2 H, 2 T \end{gathered}$ | $\begin{gathered} 4 \\ 1 H, 3 T \end{gathered}$ |  | $\stackrel{1}{0 \mathrm{H}, 3 \mathrm{~T}}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |
| 69. | 5th rows | 1 | 5 | 10 | 10 | 5 | 1 |
|  |  | 5H,OT; | 4H,IT; | 3H,2T; | 2H,3T | 1H,4I; | OH,5T |
|  | 6th yows | $6_{H}^{1}, \mathbf{O T}$ | $\stackrel{6}{5 \mathrm{H}, \mathrm{IT}_{3}}$ | $\stackrel{15}{4 \mathrm{H}, 2 \mathrm{~T} ;}$ | $\begin{gathered} 20 \\ 3 H, 3 T ; \end{gathered}$ | $\stackrel{15}{2 \mathrm{H}, 4 \mathrm{~T}}$ | $\stackrel{6}{1 H, 5 T}$ |
|  |  | $\stackrel{1}{\mathrm{OH}, 6 T}$ |  |  |  |  |  |

70. Less than you would expect. You would expect to get 20 heads when you tossed a coin 40 times.

## C. Drawing Marbles

72. Put three marbles, onered one green and one Jellow, into a box you can'tgee through, without looking take out one marble, keep a record of the colour in this table.

| Red | Green | Yellow |
| :--- | :--- | :--- |
|  |  |  |

Put the marble back in the box, mix the marbles and draw again. Do this 50 times.
(a) Did you get about the same number of each colour? $\qquad$
(b) What are the outcomes of this activity? $\qquad$
(c) Did you get each outcome about $\frac{1}{3}$ of the time? $\qquad$
72. Put three marbles, two white and one blue into the box. Do as you did in frame 71. Mix, draw, keep a record and put the marble back in the box.

| White | Blue |
| :--- | :--- |
|  |  |

Do this experiment 50 times.
(a) What are the outcomes of this activity?
(b) Did you get the outcome, blue, about $\frac{1}{3}$ of the time?
(c) Did jour expect to get blue as often as you got white
71. (b) Outcomes of the activity are, Red; Green; Yellow.
72. (a) Outcomes are white and Blue.
(c) $\mathrm{NO}_{-}$
73. Put six marbles in a box. Three marbles are red, two are blue and one is green. Without looking, take out one marble. Keep a record of the colour in this table.

| Red | Blue | Green |
| :--- | :--- | :--- |
|  |  |  |

What are the outcomes of this activity? $\qquad$
$\qquad$ , $\qquad$ -
74. Suppose the experiment in frame 73 was repeated 100 times, about how many times would you expect to draw out a red marble? $\qquad$
75. Kamau and Omungu, each has one white and one green marble, Kamau picks one of his marbles without looking and then Omungu picks one of his, also without looking. The four possible outcomes are listed in the table on the next page, complete the table on the right to show the outcomes in a shorter way.

## Answers:

73. Outcomes are Red, Blue and Green.
74. About 50 times.

|  | aran's | $\begin{aligned} & \text { Omungu's } \\ & \text { Marble } \end{aligned}$ |  |  | Omungu's <br> Marbles |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | White | White | 1. | W | W |
| 2 | White | Green | 2. | \% | - |
| 3 | Green | White | 3. | G | -- |
| 4 | Green | Green | 4. | - | -- |

76. There are two bage in Okija's house. In the ifirst bag, there are two marbles, Red and Blue. In the second bag, there are again two marbles, Red and blue.

Sonetimes we can use a table such as the one shown below to help find the possible outcomes.

|  | Second Bag |  |  |
| :--- | :---: | :---: | :---: |
|  | Red | Blue |  |
| Pirst | Red | Hed, Red |  |
|  | Blue | Blue, Red |  |
|  |  |  |  |

Complete the table.
How nany possible outcomes are there?

Answers:

76.

Second Bag

Pirst
Bag.

There are four possible outcomes
77. In the table in frame 76 the left side shows the colour of the marble taken fram the first bag. This colour 1s show first in the row. The top if the table show the colour from the bag.
78. Okiya now has three bacs in his house. In the firgt bag, there are one red and one blue marbles; in the second bag, there are one red and one blue marbles and the third bag contains one red and one blue marbles. How many outcones are there for the three bags? $\qquad$

Answers:
77. Second Bag.
78. Eight outcomes for the three bags.
79. The outcomes in frame 78 can be put in a table such as the one below. The outcomes for the two bags are on the left. The top of the table shows the outcome from the third bag. Complete this table.

79. Outcome from the third bag

80. Fach the wo add bax, wo double (mitiply by 2) the mbor of outcomes. For instance, Mth one bas ther wore 2 outcones (hod. Hise): Wth 2 baeg therv were a outcomer (Reds Rods Rods Bleos Rives Reds Bluos Elvo) and with 3 bare, there are ___ outcomme.


81. The mmber of outcones increnses by perere of 2. The mober of ontcomes for one bag in 2. The rumber of cutcomen for two buge in $2^{2}$

- $2 \times 2$ - *

The maber of out conad for 3 bage in $\qquad$
$\qquad$ $=$

80. 8 ertcome.

$$
\begin{aligned}
& \text { \& R 2 \& R B \& BR, \& B B B \& R } \\
& \text { B B B B \& B B B }
\end{aligned}
$$

81. $2^{3}-2 \times 2 \times 2-8$.
D. Solnaing the Pointer of a Boinner.
82. 



On the left is a picture of a spinner. It is divided into two equal parts. One part is red, the other part is blue.

If you spin the pointer of this spinner 100 times
(a) How nany times is it likely to stop on red? $\qquad$
(b) How many times is it likely to stop on blue? $\qquad$
83. If you were to play a game with the spinner in frame 82, you would win if the pointer stcpped on red, your iriend would win if the pointer stopped on bluo.

Write $T$ if you think the statement below is true. If it is false, write $F$.
(a) I would be more likely to win the game since the pointer would stop on red most of the time $\qquad$
(b) My Iriend would win most of the time $\qquad$
(c) Both of us would have equal chances to win this game since the pointer would stop on red about the same number of times it would stop on blue. $\qquad$
82. (a) 50 times
(b) 50 times.
83. (a) $F$
(b) $F$
(c) T.
84. Spin the pointer of the spinner shown in frame 82, 20 times. Keep a record of your results in a table below*-

| No. of times <br> pointer stops | No. of times <br> it stops on |
| :--- | :--- |
|  | blue. |

(a) How many times does the pointer stop on red? $\qquad$
(b) How many times does the pointer stop on blue? $\qquad$
(c) Would you expect the pointer to stop on red the same number of times as it would stop on blue? $\qquad$
85. About how many time would you expect the pointer of frame 82 to stop on red if you spun the pointer 400 times? $\qquad$
84. (c) Yes
85. About 200 times.
86.


The pointer on the left is divided into two sections. The red section is $X$ of the whole and the blue section is of the whole. Spin the pointer of this spinner 20 times and kop a record of your results in a table below.

| No. of times <br> pointer stops <br> on red | No. of times <br> pointer stops <br> on blue |
| :--- | :--- |
|  |  |

87. Refer to frame 86.
(a) How many times did the pointer stop on red? $\qquad$
(b) How many times did the pointer atop on blue? $\qquad$
(c) In the pointer equally likely to stop on red as on blue? $\qquad$
88. About how many times would you expect the pointer to stop on bine if the pointer of the spinner in frame 86 were spun 400 times $\qquad$
89. (c) No.
90. About 300 tines.
91. 



The spinner on the left is divided into 3 equal parts. Each part is $\frac{1}{3}$ of the whole.

Spin the pointer of this spinner 20 tines and keep track of the outcomes in a table such as this.

| No. of times <br> pointer falls <br> on blue | No. of tines <br> pointer falls <br> on red | No. of times <br> pointer fails <br> on yellow |
| :--- | :--- | :--- |
|  |  |  |

90. Refer to frame 89.
(a) How many times did the pointer stop din red? $\qquad$ on blue? $\qquad$
(b) Is each of these colours equally likely? $\qquad$
91. If you were to spin the pointer of the spinner in frame 89900 times, about how many times would you expect it to fall on s
(a) Red?
(b) Blue?
(c) Yellow? $\qquad$
92. (b) Yes.
93. 300 times; 300 tines; 300 times.


The spinner on the left is divided into six equal parts. Maura spun the pointer of this spinner 20 times and kept a record of her results in a table such as this:

| No.01 <br> times <br> pointer <br> stops on 1 | No.0f <br> tines <br> pointer <br> steps on 2 | No. of <br> times <br> pointer <br> stops on | No.0f <br> times <br> pointer <br> stops on | No.0f <br> times <br> pointer <br> stops <br> 5 | on |
| :--- | :--- | :--- | :--- | :--- | :--- |
| times |  |  |  |  |  |
| pointed |  |  |  |  |  |
| stops |  |  |  |  |  |
| on 6 |  |  |  |  |  |

(a) How many times did her pointer stop on 13 $\qquad$
(b) How many times did it stop on $2 ?$ $\qquad$
(c) How many times did it stop on 3 ?
(d) How many times did it stop en 4 ? $\qquad$
(e) How many times did it stop on 5 ? $\qquad$
(1) How many times did it stop on 6 ? $\qquad$
93. Refer to frame 92.
(a) Is each of the numbers equally likely? $\qquad$
(b) If Mana spun the pointer of the spinner 600 times, about how many tines would she expect it to stop on 4 ? $\qquad$
92.
(a) 4 times
(b) 5 times
(c) 1 time
(d) 2 tines
(e) 3 times
(f) 5 times.
93.
(a) Yes
(b) About 100 times.
94.

Tifs tetrahedren has ane of 1 te Incon coloured red, one blno, enother yollow, and the last greano Toss the tetrahedron 20 times and note the face th is down. Reep treck of the outcones in a table such ne thiss

50215
Total


How many timos did the tetrabodzon fall

95.
(i) Add the armber of times it foll an red and on Rlue $\qquad$
(i1) Add the mumber of times it fell on - green and jellou $\qquad$
(111) Is each of thase eras about $\%$ of the total namber of tosses, of about $x$ of the total nember of tosses? Abort $\qquad$
96. If you were to throw the tetrahedron in frame 94 1,000 times, about how many times would you expect it to fall on red?


Look at this 3-sided spinner which is divided into 3 equal parts. If you spin it 42 times, how many times would you expect it to fall on the black edge? $\qquad$
98. If after 60 spins of the spinner in frame 97 you had recorded 23 times for the red edge, would this be less or more than you would expect? $\qquad$
99. Four girls, Maia, Betty, Carry and Anyango, each used the spinner shown on the right.

ANSWERS
96. About 250 times.

97. 14 times
98. More.
99. They drew a bar graph show below.

No. of Blues in 50 spins


Total


Number of Blues in 200 spins.
(a) Who had the smallest number of blues in 50 spins? $\qquad$
(b) Who had the largest number of blues in 50 spins?
100. Refer to frame 99.
(a) How many reds did Betty get in 50 spins? $\qquad$
(b) Which of these fractions tells about how much of the dial is blue?
\% \% $\quad x$, *
99. (a) Anjango
(b) Cairo.
100. (a) 40 reds
(b) $\%$.
101. Refer to frame 99.
(a) Did any girl get 25 or more blue? $\qquad$
(b) How many times in all was the spinner spun by the girls? $\qquad$
102. (a) How many of the spins ended on blue? $\qquad$ is this about the number of blues you would expect on 200 spins? $\qquad$
103.


Look at these spinners. You can use fractions to compare the chances of different results. Complete the following. $K$ of dial red means 1 chance in 2 means chance of red $=k_{\text {。 }}$

K dial blue means $\qquad$ chance in 2 means chance of blue=
101. (a) No girl got 25 or more blues in 50 spins. (b) 200 times.
102. 48.

Ho. We would expect about 50 spins.
103. 1 chance in 2 means chance of blue $=1 / 2$.
104. Look at the spinners in france 103.
(1) $\frac{1}{3}$ of dial red mane 1 chance in means chance of red - $\qquad$
(11) $\frac{1}{3}$ of dial blue means $\qquad$ chance in 3 means chance of blue - $\qquad$
(iii) $\frac{1}{3}$ of dial yellow means $\%$ chance in $\qquad$ means chance of yellow - $\frac{1}{3}$ $\qquad$
105. Again look at the spinners in frame 103.
(i) Of dial red means __ chance in $\qquad$ means chance of red $=$ $\qquad$ -
(11) of dial blue means chances in 4 Means chance of blue . $\qquad$ -
106. Refer to frame 103.
(i) 111 of dial red yeans red is certain means chance of red $=$ $\qquad$
(ii) of dial red morns red is impossible means chance of $\mathrm{med}=$
104. (1) $\frac{1}{1}$ chance in 3 means chance of red $=\frac{1}{3}$, (iii) 3.

1053 chances in 4. chance of red = $x$
106. (1) Chance of red $=1$ (11) None.
107. stela was told that she would get Shs.20/0 11 she could get one of the following outcomes:-

1. Blue on spinner whose dial is Med and K blue 。
2. 42 on one toss of a die.

Which one would she choose? $\qquad$
107. She would choose blue on a spinner whose dial is $1 / 2$ red and $/ 2$ blue, because she would have half the chance of getting Shes. 20/=.

If she chose a 2 on one toss of a die, she would have only $\frac{1}{6}$ chance of getting the She .20/=.

## SETP-TEST 2

1. Awinja spins the pointer of a spinner 100 times and gets 35 reds. Which of the following statement is most likely to be true?
(a) The dial of the spinner is all red.
(b) The dial of the spinner is one-half- blue.
(c) The dial of the spinner is ono-aigth red.
(d) The dial of the spinner is one-third red.
2. Oautsimi spins the pointer of a spinner 100 times and gets 25 red, 25 blue and 50 yellow. Which of the following statements cannot be true?
(a) The dial of the spinner is one-fourth yellow.
(b) The dial of the spinner is One-third green.
(c) The dial of the spinner is one-fourth blue.
(d) The dial of the spinner is all red.
3. A spinner has a dial that is one-third red, one-half white, and one-sixth blue.

Which of the following cannot result from exactly 100 spins.
(a) 30 reds, 50 whites and 20 blues.
(b) 40 reds, 40 whites and 20 blues.
(c) 50 reds, 5 whites and 10 blues.
(d) 60 reds, 40 whites and 0 blues.

## Answers:

1. (d) The dial of the spinner is $\frac{1}{3}$ red.

2 (a),
(b);
(c).
3. (b) ;
(c),
(d).
4. You wish to get exactly 5 reds and 5 blues in 15 spins. Which of the following dials could not give this result?
(a) Ono-half red and one-half blwe.
(b) One-third red, ono-third blue and one-third jellow.
(c) One-fourth red, one-fourth blue and one-half Jellow.
(d) One-ifith red, two-fifths blue and two fifths yello
5. In which of the following is the chance of red equal to $x ?$
(a) One chance in two of red.
(b) Two chances in four of red.
(c) One chance in five of red.
(d) Two chances in eight of red.
6. Which of the following spinners is likely to give about the same number of reds and jellows?
(a) One-nalf red, one-fourth yellow, one-fourth blue.
(b) One-third red, two-thirds Jellow.
(c) One-third red, one-third yellow, one-third blue.
(d) Four-ifths Jellow, one-fifth red.
4. (a);
(c);
(d).
5. (d)
6. (c).
7. If the dial of a spinner is all red, we say the chance of red is equal to:
(a) any other chance.
(b) one chance in two.
(c) one-hall.
(d) one.
8. If the dial of a spinner is all blue, we say the chance of red is equal to:
(a) one
(b) zero
(c) one chance in one
(d) one-half.
9. The dial of spinner is one-third red, one-third yellow, and one-third blue. Which of the following statements are true?
(a) Red, yellow, and blue are equally likely to occur.
(b) The chance of getting red is equal to $\frac{1}{3}$.
(c) One spin must result in either red or yellow or blue.
(d) The chance of getting green is equal to zero.
7. (d)
8. (b)
9. (a); (b); (c).
10. If the chance of red on a spinner is equal to zero, which of the following statements could be true?
(a) The dial is all red.
(b) The dial is all blue.
(c) The dial has at least two colours.
(d) The dial has at least three colours.
11. The spinner shown on the left is divided into two
 equal parts. One part is painted red, the other part is painted blue. Tabu spins this spinner twice. Complete the table below ta show the possible outcomes.

|  | Second Spin |  |  |
| :--- | :--- | :--- | :--- |
|  |  | Red | Blue |
|  | First | Red |  |
|  |  |  |  |
| spin. |  |  |  |

10. (b) (c).
11. 

|  |  | Second Spin |  |
| :--- | :--- | :--- | :--- |
|  | Red | Blue |  |
| First | Red | Red, Red | Red, Blue |
| Spin. | Blue | Blue, Red | Blue, Blue |

12. A coin is tossed once and the spinner shown below is spun once. Complete the table below to show all the possible outcomes The dial of the spinner is divided into three equal parts.

(a) How many possible outcomes are there? $\qquad$
(b) How many of these outcomes give a head and red? $\qquad$
13. 

Spinner

|  |  | Spinner |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | $R$ | $B$ | $Y$ |  |
| Coin | $H$ | $H R$ | $B B$ | $H I$ |
|  | $T R$ | $M B$ | $T Y$ |  |

(a) There are 6 possible outcomes
(b) One outcome gives red and a head.


The dial of the spinner shown on the left is divided into four equal regions. The pointer of this spinner is spun twice.

Complete the table below to show all the possible outcomes. Second Spin First Spin

|  | 1 |  |  | 4 |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 1,1 |  | 1,3 |  |
|  |  |  |  |  |
|  |  |  |  |  |
| 4 |  |  |  |  |

What is the total number of outcomes? $\qquad$
13.

Second Spin


There are 16 outcomes.
14. Toss three coins together. Fill in the tables below to show all possible outcomes.

(a) What is the total number of outcomes when three coins are tossed? $\qquad$
(b) How many of these outcomes include three heads? $\qquad$
(c) How many of these outcomes include two heads and one tail? $\qquad$

| 14. |  | Second Coin |  |  | Third Coin |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | H | H | Pirst |  | H | T |
| Pirst | H | HB | HT |  | HH | HH\% | HHT |
| Coin | T | TH | TT | and | Hx | HTH | HMT |
|  |  |  |  | Sccond | 粗 | THH | THT |
|  |  |  |  | Coin | TT | TTH | TTT |

(a) There are 8 outcomes when 3 coins are tossed.
(b) One outcome includes 3 heads.
(c) 3 outcomes includes 2 heads and 1 tail.
15. Complete this table to show all the possible outcomes for two tosses of a coin.

|  | 21, 02 | 14, 17 | O8, 25 |
| :---: | :---: | :---: | :---: |
|  | [14 | HT | TE |
|  |  | TH |  |
| Ro. 05 Outcones | 1 | 2 | 1 |

16. Complote the table for 3 tosses of a coin.

17. 

|  | 2H, OT | 1H,1T | OH,21 |
| :---: | :---: | :---: | :---: |
|  | 188 | HT | TT |
|  |  | TH |  |
| Ho. of Outcomes | 1 | 2 | 1 |

16. 

|  | 3H,OP | 2H,21 | 18,27 | OH,32 |
| :---: | :---: | :---: | :---: | :---: |
|  | HB\% | HET | , 92 | TMr |
|  |  | HTH | THT |  |
|  |  | THI | TYH |  |
| $\begin{gathered} \text { Wo. or } \\ \text { Outcomes } \end{gathered}$ | 1 | 3 | 3 | 1 |

## SECIIONTII - Finding Probabilities

## Introductions-

Then wo talk about the probability of a particular outcome, we tell how likely it is that the outcome is the one we get. Wee use a number that tells what part of the total outcomes we expect a particular ane to happen. This moans that probabillties can be mitten as fractions.
108. When tossing one die, wa have six outcomes. We mete the 6 under the bar of a fractions

## 6

Getting the outcome 3 is just as likely as an others. 00 we expect it about $\frac{1}{6}$ of the time. wee cay. "The probability of 3 is $\qquad$ we write $P(3)=$
109. In the experiment, "Rousing a coin once", there are 2 outcomes. Since the outcomes are equally likely, we can any that

$$
\begin{aligned}
& P(\text { heads })=\frac{5}{2} \\
& P(\text { tails })=\frac{7}{2}
\end{aligned}
$$

110. Sonatinas we give probabilities for thing that cant possibly happen. In tossing one die. there is no chance at all of getting the outcome "7"。

Answers
108. $\frac{1}{6} \cdot\left(P(3)=\frac{1}{6}\right.$
109. $P($ beads $)=x$

Tho number of times you would get 7 in tossing on die is _._ We could write $P(7)=$ e or $P(7)=$ $\qquad$
111. He can also give a probability for a "eure thing." (That is, a thing which mast happen). If we ak, "Hat is the probability of getting a number less than seven when we toss one die?" There are six vase to get a number loss than seven. 111 six of the six outcomes are leas than 7, so vo wite: $P($ number less than 7) $=6$. $\qquad$ .
112. Is the experiment, "Tossing one die", what is the probability of the outcome 5 ? $P(5)$. $\qquad$ -
b) What is $P(2)=$ $\qquad$ $P(1)=$ $\qquad$ 3 $P(4)=$ $\qquad$ ; $P(6)$. $\qquad$
113. In the experiment, "Tossing Two Dice, there are $\qquad$ outcomes. Slice these outcomes are
equally likely, we can say


## hnavezss

110. $08 \quad P(7)-\frac{9}{6} ; P(7)=0$
111. $P\left(\right.$ manner $2 e s s$ than 7) $=\frac{6}{5}=1$.
112. $P(5)-\frac{1}{6} P(2)=\frac{1}{6}: P(1)=\frac{1}{6}: P(4)=\frac{1}{6}:$ $P(\sigma)=\frac{1}{6}$
113. 36 outcomes. (i) $P(4,3)=,\frac{1}{36}$ : (ii) $\left[(6,6)=\frac{1}{36}\right.$ (111) $H(7,1)=0=0$.
114. In the experiment of drawing Tables of 2 rene 71. jor mad one red, one free, and one follow marble. Bise drawing a red marble 18 one of the three equally likely outcomes, we can 8 gay.
$P($ red $)=P(b l u c)$ -

$P($ sot blue $)=$
115. In the experiment. "rousing tho Wife". lad the probability of the lust die showing 3 and tho second die showing as that is, find $P(3.5)$.

$$
P(3,5)
$$

$\qquad$
114. $P($ rad $)=\frac{1}{3} P(0100)=\frac{2}{3}$
$P($ green $)=\frac{1}{3} ; P($ yellow $)=\frac{2}{3}$
$P($ not blue $)=\frac{3}{3}=1$ 。
115. $P(3.5)=\frac{1}{30}$.
i16. If we toe two dice, wo can show all the possible an of tho dote on tho two dice in a table such an the one below.


Complete the fable to show all the possible sums of the dote on two dice.
127. One val to get a gu of 7 is to get a 1 on the first die and a 6 on the second die. We write this as $(1,6)$. There are fie more way to get a sun of 7. These are (.). (.). (.). (.). (.).
116.

Number on Second Die

117. $(2,5),(3,4),(4,3),(5,2),(6,1)$.
118. (a) How max entries are ther in the table? (b) How many po utble eatrice ace there whan sou tous twa Mce? $\qquad$
129. (a) of the cotrioe in the table of frome 116. how maxy are $6^{\circ} \mathrm{E}$ ? $\qquad$
(b) What is the probability of gotting a of 6 when two dice are tossed? $\qquad$
120. (i) How may of the ontries in the table of frem 116 are odd maibers? $\qquad$
(11) that is the probebility of getting the sul that is an ofd manber? $\qquad$
121. (1) How yany of tho auma in tho table of IFame 116 are elther 5 or 97 $\qquad$
(ii) What is the probability that the aun will be elther 5 or 98 $\qquad$
128. (a) 36 entries
(b) 36 poocible ontrien.
119. (a) 5
(b) $P(\tan -6)-\frac{5}{36}$
120. (1) 18 odd numbers
(ii) $P($ em is odd number $)=\frac{18}{36}=\%$
121. (1) 8
(11) $P($ cur elther 5 or 9$)=\frac{8}{36}-\frac{2}{9}$
122. Hofer to frame 116 to $\pi^{n g}$ er the followinge
a). $F($ au - 3 ) - $\qquad$
b). $P(\sin -8)=$ $\qquad$
c). $P(a v-12)=$ $\qquad$
d). $P($ ave - 2) $\qquad$
-) . E(sun - 11) $\qquad$
123. Refer to fram 116 to answer the followinge
a). $P(805=2$ or aven - 12) $\qquad$
b). $P($ au -6 or вum - 8) = $\qquad$
c). $P($ ova -5 or ave -9) - $\qquad$
d). $P(\sin \neq 7)$. $\qquad$
e). $P\left(\right.$ suxi $7^{9)}=$ $\qquad$
124.


In the epinner on the left. there aro $\qquad$ eqnally likely outcomes
(1) $P($ sed $)=$ $\qquad$
(is) $P$ (viste) $=$ $\qquad$ (iii) $P$ (yollow) a $\qquad$
122.
(a) $P($ aven +3$)-36=\frac{1}{18}$
(b) $P(s u m=8)-\frac{5}{36}$
(c) $P(B \cup=12)=\frac{1}{36}$
(d) $P\left(\right.$ suen - 2) $\frac{1}{36}$ (e) $P\left(\right.$ aud - 11) $-\frac{2}{36}=\frac{1}{18}$
123. (a) $P\left(\right.$ suan -2 or 3 un - 12) $=\frac{2}{36}=\frac{1}{18}$
(b) $P($ sun) $=6$ or ava - 8$)=\frac{10}{36}-\frac{5}{18}$
(c) $P\left(3 \times=5\right.$ or sua 9) $=\frac{8}{36}=\frac{2}{9}$
(d) $P(a x+7)=\frac{30}{36}=\frac{5}{6}$
(s) $P(\operatorname{sum}>7)=\frac{15}{36} \frac{-5}{12}$
124. 2 egmally likely outcomes.
(i) $P($ roe $) ~ K(i i) P\left(\right.$ white $=K \quad P\left(\right.$ fellow $=\frac{0}{2}=0$.
125. You played some game at tho beginning. You wore asked to decide whether or not the gamed were fair. lou found that some genes vert fair and sone very not. You saw that the gave vas fair if your winning outcome was just as likely as tho other playact. $P($ you win $)=P(\quad) 8$
126. In the gone, "Nogs one die", the rule vas"Yob wis if 1 is ur, the other player vine if 3 is up." siree $P(1)=\frac{1}{6}$ and $P(3)=\ldots$ we say that the gamer was _-_. Each one of you had un equal chance of winning.
127. In the gave of frame 126, bow many outcomes out of the 6 let neither of you win? $\qquad$ $P(n o$ ane wins $)=$ $\qquad$
125. $P($ you wis $)=$ (other player wins)
126. $P(3)=\frac{1}{6}$ Fair.
127. (outconas
$P(n 0$ one wins $)=\frac{4}{6}-\frac{2}{3}$
228. Is another gave, the rule vase "You win if en odd mazer is upi the other player vines is an oven number is up." To Ind whether or not you and your filar had equal chances to win. you form out how many of the outcomes wore odd and how ming wore oven.
a) How mad outcomes out of the 6 are ocd?
b) How many outcomes. are oven? $\qquad$
c) $P($ ord $)$.

d) $P(e v e n)=6$
229. The rule for one game using one die is z "You win if 3 is up; the other player win if a mimer greater than 3 is up." (Soc ram 19).
a) $P(3)=$ $\qquad$
b) Which outcomes are greater than 38 $\qquad$
c) $P($ outcome greater than 3) $=$ $\qquad$
130. In frame 129, who hus a better chance to yin you or the other player? $\qquad$
Angureres
228. (a) 3 outcomes ard odd.
(b) 3 outcomes are even.
(c) $P($ odd $)-\frac{3}{6}=x$
(d) $P$ (oven) $-\frac{3}{6}=\%$
129. (a) $P(3)=\frac{1}{6}$
(b) 4, 5,6.
(a) $P\left(\right.$ outcome greater than 3) $-\frac{3}{6}=\%_{\text {。 }}$
230. The other player.
132. Jor the geo. Toss one die. call the debult 1 111 sbows up; call the lemult 2 if oithor 2 or shove ups call the Hesult 3 if 3. 5, or 6 Ls up.
(a) $P($ Kosult 1)
(b) How many ontcomes हivo Result 27 $\qquad$
(c) $E$ (keault 2) $\qquad$
232. (a) Hou mars outcomes kive result 31 $\qquad$
(b) fillemult 3) =
133. Writo 4 if jou are nore likely to win and $B 18$ tbe other playor 18 Doro 12 toly to wis sor onch rule. Natto $B$ if both are equaly lisely to vino
a) You wia on Hosult 3 . lio wine on Reault 2
b) You vin on iresult 3 . He wins on any Roanlt leas than 3. $\qquad$
c) Ion vin on an even-numbored result and bo wing othervise. $\qquad$

Answers:
231. (a) P(Bosult 2) - 6
(b) 2 outcomen Rive drosult 2 .
(c) $I\left(\right.$ remult 2) $-\frac{2}{6}=\frac{1}{3}$
132. (a) 3 ontcomen give result 3.
(b) $P($ Ranuit 3$)=\frac{3}{6}-1 / 2$
233. (a) エ
(b) $Z$
(c) H.
234. Whan for toss a green dic and a Mis. torether, how many outcanes are there? $\qquad$ What is the prubability of was of these ortcome?
235. Hotor to 150 234.

The rule 208 FIon win 151 is on each dies tho other playar wiom ir 5 is an each die."
(a) Yor haw may cutcones do you wint $\qquad$
(b) $\mathrm{P}(1$ an ench dse) - $\qquad$
136. (a) Yor how masy outcomes does the other plajer win? $\qquad$
(b) $H(5$ an arod dic) - $\qquad$
(c) Jor bow many natcomes does nobody wis3 $\qquad$
(d) $\mathrm{z}(00$ an Mine $)=$ $\qquad$

## Answases

139. 36 outcoman
$P\left(\right.$ an of the ontcomen $-\frac{1}{36}$
140. (a) I Win for one outcone. That ia, I wis is $I$ have (2,2).
(b) $f(1$ on each dic) -36
141. (a) The othar player wins sor ue outcome.
(b) $P(5$ on ach dia) - 施
(c) No ane wine los 3 年 autsames

$$
\text { (d) } P\left(\text { on opo wide }-\frac{34}{36}=\frac{12}{18}\right.
$$

237. The rule iss You win if there is an oven number on tho waite dies the other player wing otherwise."
(a) Dose it eater what the outcome on the gaea diu La? $\qquad$
(b) $P($ eva s $)=$ $\qquad$
(c) $P$ (odd) $=$ $\qquad$
(d) $P(n 0$ one $w i n c)=$ $\qquad$
(a) $P($ both $w i n)=$
238. Thu rule iss "You win if 6 is an the white die, and the other player wins if 4 is an the freer die."
(a) $P(6$ on white $)$ -
(b) $P(4$ on green) $\longrightarrow$
239. In frame 138, can you get 6 on the white die and 4 on the green io at the suse time? $\qquad$ $P($ moth win) - $\qquad$
$P(20$ ane wins ) $=$ $\qquad$

Answers:
137. (a) 10
(b) $P($ even $)=\frac{1 E^{2}}{3 E}=N$
(c) $P($ odd $)=\frac{18}{36}-\frac{K}{0}$
(d) $\Gamma\left(00\right.$ wine $0=\frac{0}{36}=0$
(o) $P($ both wis $)=\frac{0}{36}=0$
140. The rule 183 "You win isl is on anch dies the other player wins if 1 is on one cis and 2 is on the other die."
a) $f(y \circ u w i n)=$ $\qquad$
b) For how any outcomes does the other player win? $\qquad$
c) P(other wins) - $\qquad$
141. In Irade 140.
e) who has a better chances to win, you or the other player y $\qquad$
b) $E($ both win $)$ - $\qquad$
c) $F(n 0$ one wins $)=$ $\qquad$
inswores
140. (a) $f($ you vim $)=\frac{1}{36}$
(b) Other player wins on 2 outcomes.
(c) J (other wins) $=\frac{2}{36}=\frac{1}{18}$
141. (a) Other player.
(b) $F$ (both win) $-\frac{0}{36}=0$.
(c) $P($ no we wins $)-\frac{33}{36}=\frac{11}{12}$.
142. The rule 18: "You win if the number on the white die io greater than the number on the green diu; tho other player wins othurwise."
(1) $P($ you win $)=$ $\qquad$
(ii) BRother wins) - $\qquad$
(iii) $P(n 0$ ono wins) - $\qquad$
iv) $I($ both wis $)=$ $\qquad$
143. Tho part of the rule witch sars. "Ho wins ot emile" is row changed to "He wins if the number on the wite die is less than the number an the green die."
a) Does this chance your chance to win? $\qquad$
b) With this chare, (other wins) - $\qquad$
and $P(n o$ one wins $)$ - $\qquad$
144. In fran 140, you found the probability of "2 on ono die and 2 on tho other". You found that tho pair would bu ether $(1,2)$ or $(2,1)$. You probably counted these outcomes and found 2 out of 36 outcomes, so the probability is $\qquad$

AnguIne
142. (1) i( you win) $-\frac{15}{36}=\frac{5}{12}$
(is) $P\left(\right.$ other wins $-\frac{21}{36}-\frac{7}{22}$
(iii) $P\left(n 0\right.$ una wins) $=\frac{0}{36}$ - 0 (iv) $I(b 0 t h$ win) 0
143. (a) NO. $\quad$ (b) $I($ other wing $)=\frac{12}{36}=\frac{5}{12}$
(c) $I(n 0000 w i a s)=\frac{6}{36}$
144. Probability $\frac{2}{36}$ or $\frac{1}{18}$

$$
-293
$$

245. Sometimes joe cannot find the probability of either this event or that event by countinge Look at this epimer. There are 2 outcome
 Just an thor are 2 outcomes for the spinner in frame 82. The spinner in free 82 has two equally likely catconos. Bo $P($ waste $)=P(\bmod )=$ $\qquad$
246. Thu eplaner in from 145 hat two outcomes, bet these butches are not equally likely. If the spinner io howest (if the pointer does not atop cis a 210 each tine it in apia).
We mould expect the pointer to atop an red about one out ar four times, so $P($ red $)=1$ and $P($ white $)=$
247. Dy looking at the spinner of fran 145 you know that it is certain the outcome will be either waite or red. $s 0$ P(oither white or red) - $\qquad$ $P($ red $)+P($ rite $)=X+$ $\qquad$

Angers:

$$
\begin{aligned}
& \text { 145. } P(\text { waste })=P(\text { red })=x \\
& \text { 146. } P(\text { waste })=x \\
& \text { 147. } 1 \\
& P(\text { red })+P(\text { waste })-x+x=1 \text {. }
\end{aligned}
$$

140. 



This epinnor is $\%$ vaite, $x$ red, $\frac{1}{8}$ blue and $\frac{1}{8}$ jellom.
(a) Are these cutcones equally 1ikely?
(b) $f($ mite $)=\%, P(b l e a)=$ P(yollow) - $\qquad$ $P($ red $)=$
149. To find the probability of afthor wilte or blua, wo add $P$ (mite) and $P(b l x e)$.

$$
\begin{aligned}
& P \text { (olthor whit or bleo) - } x+\frac{3}{8} \\
& \infty P \text { (aither white or bleo) - } \frac{4}{8}+\frac{1}{8} \\
& \text { P(olthor mite or bleo) - } \frac{4+1}{8} \\
& P(\text { ofthar infte or blus) }= \\
& 8
\end{aligned}
$$

150. To find $P$ (either blue or jellow) ve add (blus) and $P($ jellow):
P(ather blve or jollou) - $\qquad$ -
151. To find P(oither red or bluo), we add $P($ rod $)$ and $P$ (blea)
the $P($ either red or bluo) - $\qquad$

גnavers
148. (a) Ho.

$$
\begin{aligned}
& \text { (b) } \quad P(\text { bleo })=\frac{1}{8} \\
& P(\text { jellow })=\frac{1}{3} ; P(\text { red })-\psi
\end{aligned}
$$

249. $P$ (elthor white or blwo)
$P($ white $)+P($ blw $)=k+\frac{1}{8}-\frac{4}{8}+\frac{1}{8}-\frac{5}{8}$.
250. I'(alther blee or jollow) - I(blua) - I (yellow)

$$
\frac{2}{8}+\frac{2}{8}-\frac{1}{8}-x
$$

152. $P($ aithey rad or blue $)=F($ red $)+P($ blue $)$
153. Iva ont alums find olther - or probabilitien just by adding. look at the elinor below. It
 all the sane size. $P($ rod ) - $\qquad$ $P(1)=\square \frac{1}{3} \cdot \frac{1}{3}=$ $\qquad$
154. Ion can see that 3 of tho 6 parts of the spinner are neither red nor 1. iso P (anther red or 1) $\ddagger$
155. Count the parts of the ppinnor that as e red Count the parts of the planer that have 1 Put an $\mathbb{X}$ on each part of the epinoor that is esther red or 10 lion mag $\mathrm{X}^{\prime}$ a do jor have $\qquad$

Ancvarez
152. $P(\operatorname{rad})-\frac{2}{6}$ or $\frac{1}{3}: P(1)-\frac{2}{6}$ or $\frac{1}{3}$
$\frac{2}{5}+\frac{1}{3}-\frac{2}{3}$
Ion cant just add $P($ red ) and $P(1)$ to lInd Y(elther red or 1) because one section has both red and 1.
253. $P\left(\right.$ other red or 1) $-\frac{1}{3}+\frac{1}{3}=\frac{2}{3}$.
254. 2 parts are red.

2 parts have 1.
I part of the spinner is either red or 10 There is ane 40

- 296 -

255. Tow can find $Y($ esther red or 2) by adding the probebsutien of each one and then gubtracting the probability of that part of the aplomer that $\wedge \mathcal{P}$ (other red or 1$)=I($ red $)+I^{\prime}(1)-I(r o d$ and 1
$=\frac{2}{3}+\frac{1}{3}-\frac{1}{6}$
$-6-\frac{1}{6}$
$-\frac{4-1}{6}$
$=\longrightarrow$
256. $P($ aithce $\operatorname{rod}$ or 1$)=P(\operatorname{rad})+P(1)-P(\operatorname{cod}$ and 1)

$$
\begin{aligned}
& =\frac{2}{3}+\frac{2}{3}-\frac{1}{6} \\
& =\frac{2}{6}+\frac{2}{6}-\frac{2}{6}
\end{aligned}
$$

$$
=\frac{4-1}{6}
$$

$$
=\frac{3}{6}=x
$$


157. (a) What is the probability of ratting eit er

$$
3 \text { or } 5 \text { or } 7 \text { or } 118
$$

## 

156. (a) Ợ̃ outocmeß nire 2, 3, 5, 7, 9, 11.

$$
F(\text { ord })-\frac{6}{12}=x
$$

(b) Primo outcomes are 2, 3, 5, 7, 11.

$$
I(\text { prime })=\frac{5}{12}
$$

(c) Outcomes that are both ond and primo are

$$
3,5,7,110
$$

157. (a) $P$ (either 3 or 5 or 7 or 11)

$$
\begin{aligned}
& =P(3)+P(5)+P(7)+P(11) \\
& -\frac{1}{12}+\frac{1}{12}+\frac{1}{12} \cdot \frac{1}{12}=\frac{4}{12}
\end{aligned}
$$

$$
-\quad 298
$$

157. (b) $P($ did $) \cdot P(p \mathrm{cim})$ - $P($ eithor 3 or 5 or 7 or 11)


So $P$ (oither odd or primej $=$ $\qquad$
Chool your snuser by sounting.
158. When oncgin tormed, there are 2 outcomes, head or tell. The probability of a buad mowing up is X and the probablility of a tall showlat up is also \%.
sappose jox tose two colen, any a 10 cant plece and a 5 cent ploce do you think the probability of both berde sboulag we will ho 18 $\qquad$



## Answere:

257. (b) $P($ odd $)+\mathbb{P}($ prino $)-P($ ofthor 3 or 5 or 7 or 11)

$$
-\frac{6}{12} \cdot \frac{5}{22}-\frac{4}{22}=\frac{11-4}{12}=\frac{7}{12}
$$

258. 
259. (a) Complete the table.
(b) Stree there ere four outcomes. 111 equally 11roly, the probability for any sac of the outcomes is \%

So $P($ both heads $)=$ $\qquad$ and
$P($ both tails $)=$ $\qquad$ bet $P(1$ had. 1 tail $=$ $\qquad$ -

2(N). Here 13 a tabla for togging 3 coins. See frame 63.

(a) Complete the table.
(b) Slice those are $\qquad$ ontconos, all equally Likely, the probability of ad one of the outcomes 18 $\qquad$ -

Answers:
159

$P($ both beads $)=x$ and $P($ both tails $)=x$ $P(1$ head, 1 tail $)$ - $\frac{2}{4}$.
160.

(b) 8 outcomes Prang one outcome) $=1$
262. In fren 160. Pind.
(a) $P(3$ hoadg $)=$
(b) $P(3$ taile $)=$
(c) $P(2$ boads, 1 tail $)=$ $\qquad$
(d) $P(1$ bend, 2 tails $)=$ $\qquad$
162. Two vaite marbles and two green marblen are pet into a bous. If you tuke out ono marblo without lookias, wist: is the probnbility that it is whitu? $\qquad$

(b) If you tuike out 2 maiblow. do you think the probibility tiant they will both be white is still | of |
| :--- |

163. We can think of the problem in freme 162 11ke this: Uhure axd Poato, ench draw one of the marbles. The possible ortcomes are show in a tablo belov.
Uhum'e drawe


> draxs

Ponto's
noweres
163. (a) $P(3$ hends $)-\frac{t}{4}$
(b) $P(3$ taile $)=\frac{3}{3}$
(c) $P\left(2\right.$ herds, 2 tail) - $\frac{3}{8}$
(d) $P\left(1\right.$ head, 2 taj.l8) $\frac{3}{8}$
162. (a) P(white) - $\frac{2}{4}$ -
(b) 10.
163. Ubura my get a vhite masble, and Ponto gny get ang of the three othere.

How many ontcona are there? $\qquad$
Aro thase outcomes equalis likely? $\qquad$
164. W and OU are two disferent ontcomole.

Uneme can dray white and Fonto cas drav ervon, or Erato oan drav whito and Ubwer can drav Erroens bet there is only one way they can drem white and there is only ane way they can drey frean. $E(W) \quad P(O G j=$ $\qquad$
$P(W G)=\quad H(C N)$ -

265. a bas contuin maverel sarblas. dome are Ind, son white, and the rest blue. If Jou pick ono nasbie vitbout looking, the probabillty of $x$ ed in $\frac{1}{30}$ and the probability of wiste 18 anlo $\mathrm{g}_{0}$ What is the probabilsty of blno?

## Anewerys

163. There are 4 outconel.

Iee. The ortcomas are egually liselfo
164. $P(\operatorname{int}$ - N $\quad P(C 0) \cdot \|$
$P(E G)$ - Ki $P(G W)=X_{0}$
165. The probability of blue is $\frac{1}{3}$
166. A bas contains ase red marble, two white marbles. and three blue mertios. If you plak ane marble without loolding, what is the probability that it will be redz $\qquad$
167. In 5ramo 165, Find
(a) The probability thut the marble dram will will be waite? $\qquad$
(b) $P($ anable blue) - $\qquad$
(c) Hor man wite masblea must wo add to the ber to make the probability of white oymal to $\% 7$ $\qquad$
268. Uee the table of fram 75 to find the probability that
(a) Kanon picks a whito marble $\qquad$
(b) Oumge plake andite marble $\qquad$
(c) Both Kamou and Cimugu plek waito marbles $\qquad$
hnewores
166. $P(20 d)$ - $\frac{1}{6}$
167. (a) $P$ (watite anrble) $-\frac{2}{6}=\frac{1}{3}$
(b) $P\left(\right.$ narbie bina) $=\sum_{6}^{3}=12$
(c) He must edd 2 vilte marbles to the bars to mice the probability of white equal to \%.
168. (a) $P\left(\right.$ Knan picks uhite masto) $-\frac{2}{4} m$
(b) $P\left(\right.$ Oimagu picks white misble) $-\frac{2}{4}=\%$

169. Resar to frame 75. Find.
(a) P(both Kanas and Ounge plak groen marbles)
(b) $P$ (the boyn pick a sarble of the same colour)
270. Somotimes treo diacrans ase used to sbow posaiblo outcomes of an experinent and heace to calculate probabilitice of these cutoomes. When a cols is tonsed caco, wo get two outoomes, a head and a tall. We can ropresent these outcomes by a "troo" as followas


T
newares
169. (a) F(both kama and Onungu piok groen

$$
\text { marblos) - } x
$$

(b) Y(the boys plak a nirble of the same colour) $=x$
170. Ho anower is required for this frame.

172． $1 i 11$ in the tree diagram and the table to show all the outcomes ven two coins ant tossed．


Leet all the possible outcomes when 2 colas are tossed．埌． $\qquad$ $\longrightarrow$
 －
The table of the riant should holp you to rand the tron diagram．

## Answers



Outcomes when 2 coins are tossed are

The tree diagram is read iron lest to right and
sro top to bottom．For example an the top branch we have III and H2．On the bottom brasil we have 24 and tie．
27. P111 in the tree diafraen to show all the outcomee when three coln axe tomsed.

(a) Heat is the total muber of outconos whea three coins are tosmed? $\qquad$
(b) Bow many of theao ortcomes include 3 bende?


Anarart
Yimet incond gibled
cols cols

(a) 8 outcomea when three coins are tossed. $T$
(b) One outcono includen three boads.
173. (a) From the troe diātan of fram 172, find the probability of gettiog 3 boads. $\qquad$
(b) That is $P(2$ beade, 1 ta11)? $\qquad$
(c) What is $P$ (not 3 beads)? $\qquad$
174. BeIar to fram 172, to Flnd
(a) $P(n o$ heads $)=$ $\qquad$
(b) $P(m 0$ tails) $\qquad$
(c) $P(a t$ lenst 1 head) = $\qquad$
275. 2121 in the gollowing tree diagren for the marblea of sram 75.


173. (玉) $P(3$ heads $)=\frac{1}{8}$
(b) $P(2$ hozdu, 1 tridi $)=\frac{3}{8}$
(c) $P($ not 3 вовай $)$ ? $\frac{7}{8}$
274. (a) $P(50$ beuds $)=\frac{2}{E}$
(b) $P(n 0$ tails $)=\frac{1}{8}$
(a) $P($ at leust 2 bond $)=\frac{7}{8}$
175. The peasible outcones are reted from the tree. going from left to might.
Wat thase outcones $\qquad$ - $\qquad$ $-$ $\qquad$

What 10 the probability of gotelnce a wite marble from ach boy?
176. Revar to framo 275 to Iled
(a) The probabillty of getting both a white marble and a gree marble $P(W)=$ $\qquad$
(b) $P(O U)=$ $\qquad$

Angrezse
175.


Cutcons wre wites whtes inites green espeens whites sreens whites groen, greon. $P(W W)=x$
176. $(P(20)=8$
$P(C H)=\%$ 。

$$
\text { - } 308
$$

## 

2. Look at the spinner below.

the probabllitiea for asch colour ares

(a) P121 in the numarators of the "runamod probabilitican in the table abovo.
(b) Write P(relion or bluo) an an addition probleas
$P($ jollow or bluo $)=$ $\qquad$

* $\qquad$
(e) Write P(grean or, sod) as an addition probleas

Y(gruen or red) = $\qquad$ $+$ $\qquad$
= $\qquad$
(a)

(b) $P($ gellow or blue $) \cdot P(J e l l o w) \cdot I(D l u e)$

(0) $P($ grion or red $)-P(g r e a n)+P(50 d)$

1. (d) Weite f(rod or blue) an an acdition probleus $P($ red or blue $)=\ldots+$
(s) write $P(g r e e n$ or bleo) as an additico problen $P($ groen or blue $)=$ $\qquad$ + $=$ $\qquad$
(1) Vaite $P($ follow or red) at an addition problems P(Jollow or red) $\qquad$ $+$ $\qquad$

* $\qquad$
(d) I(rod or blue) $=P($ rod $)+P($ blue $)$

$$
=\frac{2}{12} \cdot \frac{3}{22}=\frac{5}{12}
$$

(a) $P($ green or blue $)=P($ green $)+P($ bluo $)$

$$
=\frac{4}{22} \cdot \frac{3}{12} \cdot \frac{7}{12}
$$

(1) $\mathrm{P}($ gellow or red $)=P($ yoliow $)+1($ red $)$

$$
=\frac{3}{12}+\frac{2}{1^{2}}=\frac{5}{12}
$$

2. Lools to the apinner below. It is divided into 12 parts, all tho same size.

(a) Give the following probablilties.

$$
P(1)=P(2)=\square P(3)
$$

$\qquad$
(b) $Y($ eithor 2 or 2) $\qquad$
(c) Kot the prine penber outconers $\qquad$

(d) $P\left(g x^{2}=\right.$ ruber $)$ - $\qquad$
(e) Inet the ontcones that are factors of 128 $\qquad$

(a) $P(1) \frac{1}{12}: P(2)=\frac{1}{12} ; P(3)=\frac{1}{12}$
(b) $H($ elther 1 or 2) $=I(2)+P(2)$

- $\frac{1}{12}$ - $\frac{1}{2}$
$-\frac{2}{2}-\frac{1}{6}$
(c) Prine miber cutcomos anes 2, 3,5,7. 21.
(d) $P($ prim mobre $)=\frac{5}{12}$
(o) Outcones that are factors of 12 ares
1, 2, 3, 4, 6, 12.

2. (f) $P$ (factor of 12 . $\qquad$
(s) Let the outcome that are aither 4 or
odds $\qquad$ $\rightarrow$ $\rightarrow=$
(h) $P($ elther 4 or odd $)=$ $\qquad$
(i) $P(n 70)$ - $\qquad$
(d) $P($ not 5$) \quad$. $\qquad$
(k) Lat the ontcomes that are noither 5 nor 6 . ————

((1) P(paither 5 mor 6) - $\qquad$
(a) $P$ (oven) $=$ $\qquad$
(a) $P$ (odd) $\qquad$
(p) P(factor of 23). $\qquad$
(1) $P(f a c t o r ~ o f ~ 22) ~-~ \frac{6}{12}=\%$
(8) Outcomes that are aither 4 or oddso

$$
4,1,3,5,7,9,11 .
$$

(b) $P$ (either 4 or odd) $-P(4) \leftarrow P$ (odd)

- $\frac{7}{2}$.
(1) $P\left(x \ngtr^{0}-\frac{12}{12}=10\right.$
(1) $P(\operatorname{not} 5)=\frac{12}{12}$
(k) Outcomes that are molther 5 nor 6
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 21, 22.
(1) $P($ neither 5 nor 6$)=\frac{10}{12}=\frac{5}{6}$
(a) $P$ (evon) $=\frac{6}{12}=\pi$
( A$) \mathrm{P}$ (odd) $-5=x$
(p) $P($ factor of 23$)-\frac{1}{12}$


## APPENJIX 8

## COIVEMRLOHLL IASTRUCTION

## PIOBABILTISX

## IMTEODUCTIOR

Probability is an impertant branch of mathenatice. It is used in making decioion in allitary operntions, eoientific rosearch, deaign and cunlity ooatrol of manufactured productes, insurance calculations, goveromental operutiong, otc. It is also important in all games of chance.

Whas lourning about probability therefore, you are learning about a very inpertant branch of mathenatics.

This unit is divided into three eections: Sectice One deale with "Idoas about Ohances" Section Two in on "Experiments in Probability" and Section Three is about "Pinding Probsbilities."

## SECLION OHE

## LDRAB abous chance

Purpose:
To atimulate pupils to think more


#### Abstract

objectively about chance events. Through participatice, discusaion and demonetrations by the teacherss Pupile are expected to have opportundies to test thoir intuition regarding the results of some activities involving chance, and to make guessea, e-timater, and prediction about such resulte.


Obiectivens Throughout thil section,

1. pupile will be able to think objectivoly about chance events;
2. pupile will be able to distinguish betwoas expected and experimentul outcomes of events.

## Tespon 1

Purpose:- To introduce iderab about chance.

## Matarisile neadeds None

Hathenatical merde to be lenrneds Chances probability; certaias uncertaln; probablys likelys milikoly.

## Introduction:

Todey we are poing to leam about chnoce. Some of you have honsd etatements that talk about chance. For exemple, you alght have heurd or nade the following atutementes

1. It is sore likely that I shall tio to seo Ey uncle duriad the holiday.
2. Chances ure good that my father will buy en ehint at the and of this month.
3. Kamau and Baram have equal chances to win. 4. I a drmont cortain thit $I$ can come to your house after school.

These seatences are alike in one way. They have words and ideas which are used in a part of enthonitice called probabilitye in probability, we are interested in thing which happen by chance. By using mathentics we can often estin te quite accurately what will nrobably happen.

The propils should diacuss the inplicatione of atatenente 1 to above.

1. How try to answez the following questions.
a) Waich Iootball club will win the fanat and Central African Club Championahipe next your?
b) Will all the menbere of your class be in school next Monday?
2. Bome thinga are sore likely to happen than others.
a) Which is noxe likely, thit ano of the pupils is this cleas will be absent or that the mathematice teacher in thio - Lase will be absent?
b) Which 1a more 1ikely, th t you will have ngall fos oreatiant or that jou will have mpill for lunch?
3. Some things axe more likely to happen than not.
a) In $K$ Lama in July is it more likely than not that it will rain at noon?
b) Is it sore iskely thra not that you can find the anm of 324 and 4652
4. Sono things are certain and sone thinga are iposeible. Which of the following evonte are certaln or 1rpoasiblei
a) A man can live without water for throe nonth".
b) Rarasa's dog can write his firat and last nomes in guntil.
c) 412 now care 150 China this Joar will use water for suel.
d) Tomorrow, today, will be jeaterday.
5. Our ideas about chance night be classified ae certain, uncertain, or impossible.

In the following sentences write $C, V$ or I for certain, uncertain or impossible.
a) $\qquad$
b) $\qquad$ a river lowe dompill.
c) _ wo will see the mun tomorrow.
d) $\qquad$ $\triangle$ river flows uphill. - I I will not sleep at all this week. 1) A river is deep today than yesterday.
6. Wen we say a teacher gives a test on Friday, it does not mean wo are sure he is going to give one this Friday. Wee can use numbers to tell how likely it is that be will give a test this Friday.

Mrs. Obenga gave a test on 3 Fridays out of every 4 last year.

Mr. Ogoti gave a test on 7 fridays out of - very 8 lest year.

Mrs. Oriya gave a test on 2 out of every 3 Pridaje last year.

Mra. Oyer gave a test on 20 out of every
21 Friday last year.
(a) Who is the most likely to give a test on Friday?
(b) Who is the least likely to give a test on Friday?
If you know a teacher usually given a
test on Friday, you decide to study a littlo more
on stmuredas night.

## Lasson 2

Furposes 20 extend the children's uaderstanding of the ideas about chunce.
Matoriain maoded: Dice. Mathenaticel Worchs Outcome, posaible, Sair, unrair. Rovien Chance, Cortain, Likely.

## Introductions

Oo quickly through the last lessons by ackipg chilluran questions.

## The Leasomia

CLabs Discuacion Exeroinone
Show the children a die.

1. How man faces has this die?
2. Can you mane the aumber of dote on ach face?
3. If I toss this die onoe, how many pocaible outconse are there? which are these outcomes?
4. If a die is tossed, the face thet is on top
is the one that counte.
Uraw a die on the board to show the face that counts.
5. Look at the die on the bonrd, which face choore up?

Hew many times are each of the numbers on the die likely to show on the top face if metoss the die once?
6. If wo toss a die are thore equal chances that a nuber on any of the six races will show up?
7. If eveata have equal chances of occuring, wo eay that they are equally likely. If you were playing a gane with a friend and each one of you had an equal chance of winning wo would esy thit the gam was Pnir. Bet if one of jux had more olhances of winning, we would say that the gane mas unfair.
8. Imeginc that you are playing a game with your sriend. For each gane a rule ia given that telle who wins. If ailther plajer wins, the gane is a tio. Try to tell whether each gane is fair and, if not, who in more likely to win, you or the othor player?

1. Use one die.
e) You win if 1 is up. The otber player vine if 3 i.a up.
b) Ion win if an odd number is up. The other player wins if an oven number is up. Prat list the est of odd numbers and the set of oven numbers. Axe these outcomes equally likely?
c) You win if 3 is up. The other player wing if a nobler greater then 3 is up.
2. For these games, if 1 is up, call it Result 10 If either 2 or 4 is up, call it liesurt 2. If 3. 5, 6 is up, call it Result 3.
a) Yo e win on suit 3. The other player wins on Result 1.
b) You win 年品 $^{\text {burt } 3 \text {, and he wins on any Result less }}$ than 3. $\qquad$
c) You win on an even-numbered Result, and be wins, othervico. $\qquad$
3. Use two different colours, perhaps one white and one green. Toss them together. List all the 36 possible outcomes for a toss of two dice.
a) You wis if 1 is on each die. The other player win if 5 is on each cire.
b) You win if there is an even number on the white die. The other player wins otherwise. $\qquad$
c) Ion win if 6 is on the white die, and bo why if 4 is on the green die. $\qquad$
d) You wis if 1 is on each die. He win 15 one die has 1 and the other has 2. $\qquad$
e) Iou win if the member on the white die in greater than the muser on the grocer die. Ho wins otherwise. $\qquad$
4. Use one die, and throw it two thar for each Bans. $^{\text {and }}$
a) You win 11 the mover the second tina is greater than the muser the first time. Otherwise, he wins. $\qquad$
b) Iou win if the number each tim is even. Ho win if tho manor ouch time is od.

## Lesson 3.

furppes- To extend the children's understanding of the idens about chance.

Material meodedi- dice. spinners.
Words to be learnodse Outcome.

The word outcome is often used in tallying about probability. Poople often aet, "How did the football game come out?" or they right say What
was the outcone of the football gano?"
In probability when we talk about the outcomes of an cotivity, we man all the things that can happen (all the posaibilition). Yor - football gaw. for examplo, there are three possibilities or ontcomess Your tean will win, jour tean will lose, or it will be a tio. If $2 l l$ the outcones are oqually likely, their probablilities are equal.

In order to see whether or not the outcomes Sos any gan are equally likely it is bettor to nake a 11st of outcomes.

## - GLit is Drecuingor

1. What are the outsomes when ans die is toszed?
2. Are these outcomes equally likely?
3. How many outcomes are there when you toss two dice.

To make a list of the outcomes when two
dice are tomesd jou onn make a table
much an the one belows

Green die


Gumplate the above table then mower tide Colloufing generations:
(1) Low many different mimer para are shown is the table?
(14) How mun outcomes are there for tossing two dice?
(is) Are all these outcomes equally likely?

Dote that the filmy number is the outcome on the white die. and the second number is the outcome on the green die.
3. Drew this pinier on the board. It is half white and hall red.

Suppose you spin tirmposalter of this spinner ace and it does not stop on the boundary.
a) How many possible outcomes are there? init these outcomes.
b) Are those outcomes equally likely?
C. Look at the spinner on the left.
a) What are the outcomes if the
 pointer of this spinner is spur once?
b) Are the outcomes equally 214e2y?
e) The rule is you via if the pointer stope on X, you lose if it stope on X . Do you want to play?

## EXERCISES

For acing give a role is given that tells who rime. If mither player wins, the gand in a tie. Ty to tell whether each game is fair and. If not who is more likely to win. If the gam is fair, write "F". If you are more likely to wing write "Y". If the other player is more lively to win, wilt e "O".

1. Use ode die.
a) You win if 1 is up. The other player wing if 3 la up. $\qquad$
b) You win is an odd member is up. The other player wins if an even member is up.
e) You win if 3 is up. The other player wins if in murmur greater than 3 is ups -
2. For those grass, if 1 is up, call it Result 1. If either 2 or 4 is up, call it Result 2 . If 3. 5, or 6 is up, call it Result 3.
a) You via on Result 3. This other plover wine an T̄esult 1. $\qquad$
b) You win on Homult 3, and ho wine on any Result less than 3. $\qquad$
e) You win an an evna-aurbered Result, and he vines otherwise. $\qquad$
3. Dee two dion, and white and ane green. Toss then together.
a) You win is 1 is on each die. The other player wins if 5 is on each die. $\qquad$
b) You win if there is an even number on the white die. The other player wins otherwise $\qquad$
e) You win if 6 is an the white die, and ho wins if 4 is on the green die. $\qquad$
d) You win if 1 is on each die. Ho wins if one die has 1 and the other has 2. $\qquad$
-) You win if the member on the white die is greater than the number on the green die. He wins otherwise. $\qquad$
4. Use an die and throw it two tines for each game.
a) You via if the number the second tin is greater than the number the first time. Otherwise, bo wins $\qquad$ -
b) You win if the number ouch time is even. Ho wins if the member each time is odd.

Se a) What are the ontocmes when jor tore one die? Whet the outcomes.
b) What are the outcomes when fou toss two dice? LIst the: ie outcomes.

## SEOPLOHLIT



Objectives

To help the pupils with the techniques for gathering, tabulating. Graphing and interpreting data mich they generate by tossing a coin. tossing a die, drawing marbles and spinning the pointer of spinner.

The idoan gained from activities should sharpen children's intuition abort chance events by analysing the results of a lace number of trials.

Pocabulnys Tabulate. horizontal vertical. tell.

Materiel poedodi- Spines. coins 5 - cent ploce. 10 - cent piece and 50 - cent piece. dice. mates.

Lesson 4 and $5:=$ 20aving a die.

Fusuolleze To extend childron's Ldone aboot chance evante by involving thea in experimintal MOİ。

Materialat = Iten toaned a die 20 thres and recorded ber ortcomes in the following tablei-

study the table ocrefully and 800 how many timea each face of the die showed up.

1. Iou now tose a die 60 times and make a reoond of the miber of dets on the top lace. Pocord jour resulta in a table much an the ane show above.

How anaver tho lolloring guestions
a) How many 1 's did you get?
b) How many $3^{\prime} s$ did you हet?
c) Did you get each outcome about the same amber of timos?
d) How enay tires did you expact to got ach ontcose?
2. Jose a die 100 times. Keep a record of jour reaults in the table below.

a) Ind fou get orch outcome abort the nance number of time st
b) Does your experiment make you think that in the long rn you are inkely So got each outcome 1 time in 68
3. In question 1 you tossed a die 60 times and recorded your results in table. Use these results to dray a graph.

4. Toss a die 10 times and record your results in the following table.

a) Prow your totals, which race of the die was up the most? $\qquad$
b) Are any two or acre totals the ane? - Which? $\qquad$
c) Would you expect that on 10 tosses, each number would cone up at least once? $\qquad$
d) (1) If $w$ tossed a die 1000 times, could wo be sure that ovary number would cone up at least once? $\qquad$
(ii) How many timer would you expect every number to come up when you toss a die 1000 times?
5. If two ale are tossed at the sane tin there are 36 possible outcomes. the cans represent these outcomes in a table such is this.

number on first die

Complete the above table to show all the possible outcome n in a throw of two dice.

In the table, the rivet number in the ordered pale, say $(1,2)$, refer to the outcome on the siret die while the seconal number refers to the outcome an the second die.

Susan 6 and 73 Tossing a cola
Purines To extend children'e ideas about chance events.

Materials Coin - 5 - cents pieces 10 - cent place and 50 - cont place.

Maris to 2 urns - expect; notum, about.
A coin ban two faces a head and a tail (the aide of tho coin with the coat of amp in referred to as "tail").

If jor tore a coin once there is one chance out of two pessiblitios of getting a head.
(1) How many tines would you expect a head to show up?
(11) How many times would you expect a tail to show up?.

1. Maria tossed a coin 22 times and recorded her reaulta in a table below z-

a) (1) Low many tines did she get a hoad?
(ii) How many times did she get a tail 7
(is) In baber of times she got a head plus mubur of times she got a tail 10 equal to $\qquad$ -
(iv) Are hor outcomes equally likely?
b) (i) How many tines id she expect to get a hoad?
(ii) How many times did she expect to get a tall
2. Toss a coin 100 times. Sop a record of the results in a table much as this.

| So. of | No. 01 | Total Ho. Of |  |
| :--- | :--- | :--- | :--- |
|  | Loads up | tails up | Tosses |
| Tally |  |  |  |
| Total |  |  |  |

a) How many times did you expect to get the mend s"?
b) How many tines did fou actually got the Monde?
e) Did joe got the "heads" more than 40 times?
d) Did you got about an man beads an tails?
3. Foes a coin 200 times and keep a record in
a teble auch us the one shown in question 1 .
a) How many times did you get a head?
b) How many timoa aid yon rot a tail?
e) Bow nany times would you expeut to got a boad?
d) How wany times would jou expect to got a tall3
c) In the mabor of times the "heads" atoucd up closer to the number of tians you vould expect "heads" to show up?

Moter- If a coin is tossed a large munber of times, the maber of times a had actually show up would be closer to the runber of times wo would sxpect a head to show ap.

2038099 8 - 10
Furpoges To extand children's knowledpe about Ideas about expected and experimental outcomos of an activity.

Revirns actual outcomes and expected outcomes. maroghout these lessons stress the difference betvern uctual outcomes and expected outcomes. dsouning that the coin is a balanced one, i.e. if it does not ntand on its edee when it is
tossed, the actual anator of times it leods "heads" up would approximetely approach the namber of tines we vould expect it to land "meade" up.

1. Thise two coins, 10 - ceat plece and 2 5 - cent plece. Tors them torether 40 times. Recond your sesults in a toble boiows-

|  | No. OR <br> lhauds up | No. of talle up | Total Ho. of Soses |
| :---: | :---: | :---: | :---: |
| $\begin{gathered} 5-\operatorname{cost} \\ \text { cotn } \end{gathered}$ |  |  |  |
| $20 \text { - cont }$ |  |  |  |

a) How sany times à you get two heade?
b) How many times do you got two taile?
c) How many times do you got a head and a tall
d) Do you think you would get a houd and
a tail alnost 2 timas as you vould got
2 boads or 2 taile?
2. Whan two coins are tossed, say a 5-cent plece and a 10 - cont piece, they can fall in one of the following ways shown in the table below.


Canplote this table.
3. He can also dram a table to show the outcomes when two culm are tossed.

Complete the table.

4. Toe 3 coins, 5 - cont coin, a 10 - cont coin and a 50 - cont coin. Record your results in a table below.


How mang timen do you got
e) 3 heada?
b) 3 taile?
c) a head and a taill
5. If jou toss 3 coins they can lall in one of 3 dirferent maye. Conplete the table below.

6. All the outcomes from a tose of three colne cen also be shom in a table such as thiss


Complete the table then answer tho 80210uing questions-
a) How nan times are we likely to get 3 hade?
b) How many times are wo lively to get

3 tad $1=7$
c) How nan times ane wo likely to got two homed and one tall?
d) How many times are wo likely to got un band and two tails?
7. If wo toss 2 coin wo may record tho outcomes as is show in the table below-


Complete the table.
8. Mike table like the one in quastion 7 for three tosser of a coin.
9. Caplete the tabla bolow for 4 tossen of - cos.

10. We can organic the results of questions 7. 8 and 9 in a triangular form. This 18


Caplet the row for the th toss.
11. Look at the pattern in the triangle on question 10. Complete the Fth and the 6th yow ( 5 and 6 tosses of a coin) without making a table.
12. I tossed a coin 40 times and counted 28 heads. In this more or less than fou would have expected?

## Less: 11 - 12

## Draw has marbles

Puspogns Extending children's ideas about expected and experimental outcomes.

Matorlalat Marbles.

1. Pat three marbles, ane red, one green and one yellow, into box you cnn't see through. Without looking, take out one marble. Kep a record of the colour yon draw in the table below:


Put the marble back in the box, nix the marbles and dram again. Do this 50 times.
a). DId you get about the same number of each colour?
b) What are the outcomes of this activity?
c) Did you got each outcome about $\frac{1}{3}$ of the time?
2. Pat three marbles. two white and one blue into the box. Do an you did in question is fix, draw, Lop a record and put the marble back in the bor.

Do thin aperiment 50 time.

a) What are the centcona of this activity ${ }^{8}$

$\qquad$ 9 $\qquad$
b) Gupjese this experiment was repeated 100 times, about how many times would you expect to draw out a white marble?
3. Khan and Cantu, each has one white and one croon marble. Daman plats one of his antilles without looking and then Orang ploce one of hin. Iso without looting. The four possible outcomes are listed in the table below. Complete the table on the right to show the outcomes in a shorter way.

5. There are two bags in Oriya's house. In the first bag, there are two marbles, red and blue. In the second bag, there are again two marbles, red and blue.

Sometimes we can use a table such as the one shown below to help find the possible outcomes.


Complete the table.

In the above table, the left side shows the colour of the marble taken from the first bag. This colour is shown first in the rove. The top of the table shows the colour from the second bag.
6. Okla now has three bugs is his house. In the first bag, there are one red and one blue marbles in the second bay, there are one rad and ane blue marbles and the third bag contains one red and one blue maples. If oriya drams a marble io each bag, his outcomes can be put in a table such as the one below.

The outcomes for tho first two ba ge ire on the left. The top of the table shows the outcome from the third base. Complete the table.

7. Each time we add a beth, wo double (multiply by 2) the muller of outcomes. For instance, isth one bag there ware 2 outcomes - Red and Blue. With two baa there were outcomes a (reed, Redis Mod, Blue): (Blue, Rod) and (Blue, Blue).
a) How many outcomes are there when there are three bagel?
b) List these outcomes.
8. The mater of outcomes increases by powers of 2. The number of outcomes for one bact is 2. The number for two back is $2^{2}-2 \times 2$ - 4 . In the sane way, write dow the number of outcomes for 3 bags.

## Lesson 13 - 168

SPINNING THE POInTER OF SPINNER
Furgonel To extend children'e knowledge about expected and actual outcomes and to enable them to distinguish between these word e (expected and actual outcomes).

Matordeh Epinnerm.
1.

2. If you were to play a game with the spinner in question 1 , you would win if the pointer stopped on red, your friend would win if the pointer stopped on blue. Write I if you think the statement below is true. If it is false, write $F$.
a) I would be more likely to win the game since the pointer would stop on red most of the time $\qquad$。
b) My friend would win most of the time $\qquad$ .
c) Both of us would have equal chances to win this game since the pointer would stop on red about the same number of times it would atop on blue $\qquad$ .

3．Apia the pointer of the spinner shown is question 120 tiros．Kop a record of your recurve in a table bellows

| Ho．of timed | Ho．of timon |
| :--- | :--- |
| pointer stope | pointer stops |
| on sod | on blue |
|  |  |

e）Sow many times does tho pointer stop on rod？
b）How wand times does the pointer atop on blue？
e）Would you expect the pointer to stop on red the same number of times as it would stop on blue？
d）about how many the mould you expect the pointer of this planer to atop on red If joe spun it 400 times？


The spinner on the left in divided into two sections． The red suction he 高 of the anole and the blew cation is \＄of the whole．Spin the pointer of the la aplomer 20 times and keas a record of jour results in a table below．

| No. of tines | No. of times |
| :--- | :--- |
| pointer stops | pointer stops |
| an red | on blu |
|  |  |

a) How man tines did the pointer stop in red
b) How many time did the pointer stop on blue?
c) In the pointer equally likely to atop on sod as on bless
d) About how many times would you expect the polater to atop on bled is the pointer of this spinner wore spun 400 times?


The spinner on tho left is divided into 3 equal parts. Each part is $\frac{1}{3}$ of the thole. Spin the pointer of this eplancr 20 time e and top track of the outcomes in a table much an this.

a) How many tina did the pointer atop on Fed?
$\qquad$ ; en blue? $\qquad$ - on Follow $\qquad$
b) In each of those colours equally likely?
e) If you were to spin the pointer of the spinner show above 900 times, about how many time would you expect it to fall on
a) Rad?
(b) 131no?
(c) Follow?


The epinaer on the left is divided into six equal parts. Mana spun the pointer of this oplnmer 20 times and kept record of hor results in a table ouch as this.

|  | Wo.0f timas pointer etops on | Ho. of times pointer atop: 0 | Ro. Of ther polater atops a | No. Of t甶年 pointor atops on | 180.01 timal pointer stope as | N0.02 tines polnter atops on |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1 | 2 | 3 | 4 | 5 | 6 |
| Talds | /1/1 | AH | 1 | $1 /$ | /// | HH |
| Sota | 4 | 5 | 1 | 2 | 3 | 5 |

(1) How many times did Mana's pointer atop on
a) 18
b) 28
c) 38
d) 42 e) 58

1) 68
(1i) If each of the mumbere equally likely?
(iii) If Mava spun the pointer of the apinner 600 times, about how many times would she expect it to stop on 4?
7. 



This tetrahedron has one of its Laces coloured red, one blve. anotiser Jellow, and the last green.

Toss the tetrahedron 20 tiree and note the face that is dorm. Eeep track of the outcomes in a table such as this.

|  | Rod | H100 | Green | Yellow |
| :--- | :--- | :--- | :--- | :--- |
| Tun |  |  |  |  |
| Total |  |  |  |  |

a) How many times did the totrahodron fall on Red 1 $\qquad$ an B2 ne? $\qquad$ on Green $\qquad$ on Yellow? $\qquad$ -
b) Add the amber of times it fell on rod to the number of times it 1011 on Blue $\qquad$ -
c) Add the member of times it fell on green and solon $\qquad$ -
d) Is each of these curs about half of the total number of tosses, or about $\%$ of the total giber of tosses? about $\qquad$ -
e) If Jon were to throw the tetrahedron 1,000 times, about how many times would fou expect lt to fall on red?
8.


218 3 - sided spinner 15 divided into three equal parts.
a) If sou apia it 42 timaghow nan g tines would Jon expect it to fell on the black adze?
b) If after 60 spine of this spinner you had recorded 23 times for the red edge. Is this leas or wore than fou would expect?
e) Four chris, Kava, Betty, Carse and Massage, each need the spinner shown on the riftht, they drew a bar graph shown belous-

50. of blues in 200 aping.
a) Who had tin cuallest maser of blues in 50 spins?
b) Who had the largest number of blues in 50 spins?
e) How many reds did Betty get in 50 aping?
d) Which of these fractions tolls about bow mich of the dial 15 blue f

-) Did any girl get 25 or more blues?
8) How many tires in all was the splanar spun by the girdle?
6) How may of the spins ended on blue? Is this about the muser of blues you would expect in 200 spine?
10.


Look at these spinners. Iou can use fractions to ec pare tho chances of different results.

Complete the following.
a) (1) \% of dial rod means 1 chance in 2 prong chance of red $=$ Ko
(is) \% of dial blue moans $\qquad$ chance in 2 mane chance of blue - $\qquad$
b) (i) $\frac{1}{3}$ of dial rod mana 2 chance in $\qquad$ men chance of rod -
(is) $\frac{1}{3}$ of dial blue mans chance in 3 means chance of blue - $\qquad$
(iii) $\frac{1}{3}$ of dial jello meting $\frac{1}{3}$ chance in ——eanas chance of yellow $=\frac{1}{3}$.
c) (i) $X$ of dial rod meas $\qquad$ chance in - mane chance of red - $\qquad$
(ii) $A$ of dial blue moans rod is imposable means chance of red $=0$.
11. Atcks was cold that she would get she. 20/if she could get one of the following outcomes:-

1. Hive on a spinner whose dial is $h$ red and \% blue.
2. A 2 on 0 as toss of a die. Which one would she shoos? thy?

## Seantol 3:

Pipdin: Probabilitien
Introductions When we tulk about the probability of a particular cutcone, we toll how likely it is that the enteone is the one ye got. We use a numer that telle what of the total outcomen we oxpect a particular one to happon. This moans that probabilities can be wititon as fractions.

Iasacn 17 axd 18e
Pruposes- To introduce probabilityo
Hatheratical vordas Revise chance, certaino Teach probability. Revise chance evonts in the last two secticns. These section coatain elenentary ideas of probebility. slow experiments porformed ourikisy will nor: be used to draw conslusices nucut tivir outcose.

Throushout the last suction a distinction wes drawn outweon expestad and experinental resulta. Mippected reaulte are used to calculate probabilities.
2. When tossing one die, we have aix outcomes. We wefte the 6 uncer the bar of a fraction.

Getting the outcome 3 is just as likely as any of the others. so wo expect it about of of the time. Wo sag, "The probability of getting a 3 in a sinerio toss of a die is $\frac{1}{6}$.
2. In the experiment. "Tossing a coin once". there are 2 outcomes.
a) What is the probability of obtaining
a head? $P(H)=X$
b) What is the probability of obtaining a tails $P(2)=K_{0}$
3. Sometimes wo give probabilities for things that cant possibly happen. In tossing a die, there is no chance at all of getting the outcome "7".

The mater of times you would get 7 in tossing one die is $0=0 \quad P(7)-\frac{0}{6}=0$
4. We can also give a probability for a "sure thing" (that is, a thing which aust happen). For example, what is tho probability of getting a number lase ti: an 7 then ono die

1. tossed?

There are elf ways to got a number less than 7．So the probability of getting a number lean than 7 is $\frac{6}{6}$ ．1．Wo write this as
$P($ mimer less than 7$)=\frac{6}{6}-1$ ．
G2a日秋 Discussion
1．In the experiment，＂Tossing one Die＂，what in the probability of the outcome 5 ？
$P(5) \quad P(2)=\ldots P(1)=$ $1(4) \quad P(6) \cdot \square$

2．a）How many outcomes are there when two dice are tossed？Pisa
（1）$P(4,3)$（ii）$P(6,6)$
（11）$P(7,2)$（iv）$P(3,5)$ ．

3．In the experiment of＂Drawing marbles＂you used one red，one grant，and one yellow marble．What is
a）$P$（red marble drawn）
b） $\mathrm{H}(\mathrm{drawing}$ blue marble ）s
e）$P(g r o a s)$
d）$P($ yell ow $)$
－）$P($ not blue）．
Motel The outcomes in the experiment were equally 21koly．
4. If we torn two dice wo can show all the possible sums of the dots on the two dice in table such an the one below i-


Complete the above table and use it to answer question (a) to (1) below-
a) One way to got a sum of 718 to got a 1 on the first die and a 6 on the second die. We write this as $(1,6)$. Thew are five more way to get a au n of 7 . Write down the five ways.
b) (1) How many entries are there in the table?
(11) How mans possible entries are there when you toss two dice?
c) (1) Of the entries in the table, how many ere 6's?

## (ii) Than 15 the probability of getting a of 6 when two dice are tossed?

d) (i) How many entries are odd numbers
(ii) What is the probability of getting the sum that in an odd number?
c) (1) How man g of the sues are dither 5 or 98
(ii) What is the possibility that the gu x will be other 5 or 98
8) (i) $P(a \cup m$ - 3) (ii) $P(x u=8)$
(111) $P($ (avis -12) $\quad(i v) P($ sun - 2)

(vii) $P($ sum $=6$ or gu: - 8)
(vil) P (sum - 5 or ฮบต - 9)
(dx) $P(\varepsilon$ (x) - 7)
(x) $\mathrm{P}($ mum $>9)$.
5.


The eplaner on the left is divided into two equal parts. Kind
(a) $P(r e d)$
(b) p (white)
(c) 2(roilow).

Purposes = To axtend the ohildren'e underatanding of probability.

Mathenatical vorars- Rovise probability, equally likely outcome, inposible outcomes, outcomes which are certain to occur.

You plajed some games at the beginning. You were asked to deoide whether or not the ganes wore fald. You found that sone ganes were fale and sose wer not. You saw that the gane was fale if your winnlec outcone wan just as likely as the other playor's. We say that the game is fals if $P$ (you win) - $P$ (your friend wins)

## BXCROISER

1. The rule for a gaso ualig one die iss "You win if 3 is up; the other player wins if a number gruater than 3 is up."
a) What is $P(3)$ ?
b) Which outcomee are grentor than 38 What is F (outcome greater than 3)?
2. For the gane, "Toss one Dio" you oalled the Result 1 if 1 was ups you onlled the Hemult 2 if oither 2 or 4 was ups you called the Result 3 if 3, 5, or 6 whe up.
a) What is $P($ Reault 2$) 8$
b) How many outoones give Reault 28 Whit is $P($ Reault 2$) T$
c) How mans outcomes give Result 37

What 1s P(Hesult 3)?
3. Hrita $L$ if you are nore likely to wis and B if the other player is more likely to wia for each rule. Winte E if both are equally likely to win.
a) You win on Bosult 3. He wins on sobult 1 .
b) You win on besult 3. He wine on any recult lesg than 3.
e) You win on in ovenmumbered result and be wins otherwise.
4. When you toss a green die and a white die together, how many outcomes are there?

What is the probabillty of any of these outcomes?
5. The ruin iss "You win if there is an oven number on the white dies the other player wins othorwlse. Find
a) $\mathcal{H}$ (even number)
(b) P(odd number)
c) $P(n o$ one wins)
(d) $P($ both win $)$.
6. The rule iss "You win if 6 is on the white ale, and the other player wins if 4 is on the green die." Find
a) $P(6$ on white die)
(b) $P(4$ on green die)
c) $P($ both $w i n)$
(d) $P(n o$ one wine)
7. The rule lies "You win if 1 is on each dies the other player wins if 1 is on one die and 2 is an the other die." Find
a) $P($ you win)
(b) $\mathcal{P}$ (other wins)
c) $P($ both win $)$
(d) $P(n o$ one wins)
8. The rule iss "You win if the number on the piste die is greater than the number on the green die; the other player wins otherwise." What is
e) $P($ you $\mathrm{m} / \mathrm{n})$
(b) $P$ (other wins)
c) $P(n o$ one wins)
(d) $P($ both win)
9. The part of the rule which says, "Ho wine otherwise" is now changed to "lie wing if the number on the white die is jess than the cumber on the green die."
a) Does this changes jour chance to win?
b) With this chance, what is $P$ (other wins) s $P(n 0$ one wins).

Lesson 20:

Purpose: To introduce "Either - or "
Probabilities.
Mathomatical words: Teach or. Iou can mention And but do not teach it. In connection with set languafe or means union ( $V$ ) and And means intersection ( $\cap$ ).

1. In question 7 above, you found the probability of "I on one die and 2 on the other." You found that the pair would be either $(1,2)$ or (2, 1). You probably counted these outcomes and found 2 out of 36 outcomes, so jou found the probability to be $\frac{2}{36}$ or $\frac{1}{18}$.

Sometimes you cannot find the probability of either this event or that event by counting. Look at this spinner.


There are two outcomes, red and white. But these outcomes are not equally likely. If the apinner is honest, i.e. if the pointer does not stop on a line each time it is spun, we would expect the pointer to stop on red about one out of four times.

What is
a) $P(\operatorname{rad}) 7$
(b) $P($ white $) ?$

By looking at this spinner, you know that
It is amain the outcome wiI be either white or med.

What 10
e) $Y($ either waite or red) 7
b) $P(\mathrm{rad})+P($ white $)$ ?
2.


The spinner on the loft 18 $\%$ white, $x$ red, $\frac{1}{8}$ blue and $\frac{1}{8}$ yellow. These outcomes are not equally likely.

$$
P(\text { white })=K_{0} P(\text { blue })=\frac{1}{8}
$$

$$
P(\text { red })=\% \quad P(\text { yellow })=\frac{3}{8}
$$

To find the probability of ether white of blue. we add $P($ white $)$ and $P(b l u e)$. $P($ oitior white ox blue $-\%+\frac{1}{3}=\frac{5}{8}$ Find
a) $P($ either blue or yellow)
b) P(aither red or blue).

## EXERCISES

1. Look at the spinnerpbow.


|  | Rod | Blue | Yellow | Green |
| :---: | :---: | :---: | :---: | :---: |
| Probability | 6 | $x$ | $x$ | $\frac{3}{3}$ |
| Konsuad <br> Probabilities | $\Gamma$ | $\Gamma$ | $N$ | $\Gamma$ |

a) Fill in the mueratora of the "renamed probabilities" in thettable above.
b) Write $P($ yellow or blue) as an addition problem.
c) Write P (yellow or rod) as an addition problem.
d) What is P (rod or blue)?
-) What in $P$ (green or blue)?
8) What is $P($ (yellow or red)?
2. Look at the epinmer below. It is divided into 12 parts, all the same size.


What 18
a) $P(1)$ ? $P(2) P \quad P(3) ?$
b) $P($ other 1 or 2$) ?$
©) 1) Wat the prise number outcomes.
ii) What is $P$ (prise number)?
d) 1) List the outoonos that are factors of 12.
ii) $P($ factor of 22) - ?
-) 1) List the outcomes that are either 4 or odd.
ii) $P($ either 4 or odd $)=$ ?
8) $P($ number greater than zero ) - 8
c) 1) List the outcomes that are neither 5 nor 6.
11) $P($ neither 5 nor 6) $=$ ?
h) $P$ (even) - $?$

1) $P($ odd $)=3$
2) $P(n>7)=$ ?
k) $P($ factor of 23) $=$ ?
3) $P(n<0)=$ ?

Humane To extend children'a Ideas about olther

- or probabilities.

Matharation wordy Boviso gre Ether
Briefly teach the Mathematical meaning of And

Iou can't always riled either o or probabilities Just by adding. Look at the spinner below. It Ls divided into six parts, all the game size.


Ion can ace that the probability of sithar red or 1 Is rot $\frac{2}{3}$, because throe of the $s 1 x$ parts of the mpinaer ( $\%$ of $1 t$ ) are norther rod nor 2 . Ion cant frat add $P($ red $)$ and $P(1)$ to lind P(olthor rod or 1). Why.
a) How many part of the spinner are red
b) How many parts of the spinner have 18
e) Put an $X$ on each part of the spinner that in either red or 1. How many $X^{\prime \prime} \mathrm{E}$ do you have?

You an find $P($ other rod or 1) by adding the probabilities of each one and then erbitracting the probability of shat part of the opinner that base a 1 and is rod.

$$
\begin{aligned}
P(\text { olthar red or } 1) & =P(\text { red })+P(1)-P(\text { red and }) \\
P(\text { other red or } 1) & =\frac{1}{3}+\frac{1}{3}-\frac{1}{6} \\
& =\frac{2}{3}-\frac{1}{6} \\
& =\frac{4}{6}-\frac{1}{6}-8
\end{aligned}
$$

## ExERCISES

Look at the spinner below. It is divided into 12 parts, all the same size.

a) 1) Which outcomes are odd?
11) $P($ odd $)=?$
b) i) Which outcomes are prime?
ii) $P(\mathrm{prim})=8$
d) 1) What ch outcomes are odd and prime?
11) $P($ odd and primo $)=?$
iii) $P$ (either odd or prime $)=P(\ldots)+P(\ldots)=P(\ldots)$.

Follow the axguonent of the example above and then check your answer by counting.

## Lesson 222

Fugooses To extend children's knowledge about probability by ming two or more coins, splonern, masbles and dice.

Mathonationl word me Teach both

When one coin is tossed, there are 2 outcomes, head or tail. The probability of hard showing up won os e coin is tossed is $K$ and the probability of a tail showing up is also $\%$ provided the coin is "honest."

The outcome on one toss doesn't have anything to do with the outcome on the next tors. hen if jor get heads five times in a row or ton times in a row, the probability of heads on the next toss is til \%
suppose you toss two coins together, say a 10 - cent piece and a 5 - ont piece, do you think the probability of both head e showing up will still be K?

1. Here is a table for tossing two coins.

a) Complete the table. How many outcomes are there when two coins are tossed ${ }^{8}$
b) What is
1) $P($ both haida) $=$ ?
2) $P($ both tesla) -8
iii) $P(1$ hoad, 1 tall $=8$
2. Here is a table for tossing 3 coins.

a) Complete the table. How mans outcomes are there when you toss 3 coins?
b) What in

> 1) $P(3$ meads $) 8=$
> 1i) $P(3$ tailes $) 3$ -
> 111) $P(2$ mance, 1 tail) $8=$
> 10) P(1 head, 2 taile) 8 -
> -) $P($ at leust 1 head) $=?$
> vi) $P$ (at least 2 talls) - 8
3. Two white marbles and two green marbles are pet into a box. If you take out one aarble without looking, whit is the probability that it is white?
b) If you tuke out 2 marbles, what is the probability that the marbles drawn are white?
4. We can think of the problen of question 2 like this: Uhuru and Fonto, ench dravore of the narbles. The possible outcomes are shown in a table bolows

|  |  | Uhysu's dravs |  |
| :---: | :---: | :---: | :---: |
|  |  | White | Gruen |
| Ponto': | White | WW | WG. |
| drawe | Green |  |  |

a) Camplete the table. How many outcomers are there?
b) What is the probability that both boye drou a whtte marble?
c) What is the probability that the boye drew a white marble and a green marble?
d) What is the probability that the bcye drew a green marble?
5. 1) A bag contain several marbles. Som are red, sone white, and the rest blue. If Jou pick one marble withost looking, the probability of redia $\frac{1}{3}$, and the probability of white is aleo $\frac{1}{3^{\circ}}$ What is the probability of blue\%
6. 4 bas contain one red marble, two white Earble, and three blue asrbles. If jou pict one marble without looking,
a) What is the probability thit it will be red?
b) Mat is the probability that the mincle drava will be whiteis
c) $P($ marble blue $=$ ?
a) How man white marbles must we add to the bag to make the probability of white equal to x ?

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## Serson 23s

Properase To use probability trees to calculate probabilities.

Kathantion monges - Toach probability troo.
senotires tree diagrans are used to show possible outcomes of an experiment and honce to calculate probabillition of those ontcomes.

When a coin is tossed once, we gat two catcomes, a hend and a tail. Wo can reproisent those outcomes by ${ }^{\text {w } t r y 0^{n}}$ an followas
B

$$
T
$$

1. Pill in the tree diagran and the table to show all the cutcomes when two coins are tossed.


Use the tree diagran to ealculate
a) $P$ (both heade)
(b) $P$ (both taile)
e) $P(1 \mathrm{head}, 1$ tei1).
2. M11 the tree diagran to show all the ortcares whan three coln are tossed.

a) Whit is the total number of outcomes when three colns aro tossod?
b) What is $\mu(3$ hoads )?
c) What is $P(2$ haads, 1 tall $) 7$
d) What is $P(1$ hoad, 2 tails $) ?$
-) What is $P($ not 3 haads $)$ ?

1) $P($ no heads $)=?$
2) $P(00$ talla - ?
3) $P($ at 2 east 2 head $)=$ ?
3. Pill in the following tree diagram.


Pind
a) $P(H W)$
(b) $P(60)$
(c) $P(G W)=$ ?
4. Finish tic table below to show the outcomes for two spins of the spinnere

a) For the siret pin what is
a) $P(a)=?$
(b) $\mathcal{H}(B)=8$
(a) $P(x)=8$
b) For the second spin
i) $P(K)=?(11) P(B)=?(i 11) P(Y)=?$
c) For 2 aping
i) $P(R i A)=8(1 i) P(R B)=8$ (iii) $P(R X)=3$
iv) $P(Y Y)=? \quad(v) P(B B)=?$
vi) What mathematical operation connote the results of the first spin to the results of the second spin to field the results of both spines Is it (i) multiplication (ii) addition (iii) subtraction or (iv) division?
5. Do the exerciser in $\mathbb{L P E}$ Book 6 pager 156 and 197. Pase 158 nos. 2 and 3.

## APPENDIX CI

## PROBABILITY

PRETEST EXERCISES

TAMS $\qquad$
POI OR GIRL $\qquad$

TIME\& 40 MIN.
school $\qquad$
AGE $\qquad$

READ THE FOLLOWING INSLRUCIIOAS AND EXINPTES

## QANFUTETE

2. The question presented to you are designed to slid out how much knowledge of probability you already have. They are like the problems that w11 be on the lesson.
3. Read carefully and think hard before you attempt ans question. Attempt all questions.
4. Write jour answers on the question paper
5. You should work out the examples given with jour teacher.

## EXAMPLES:

1. Think of eplaning the pointer of the spinner or the right.

The pointer is likely to stop on red.
a) $N$ of the time
(b) $\frac{1}{3}$ of the time
c) O of the time
d) all the time.

circle the letter of the correct answer.
Answer. Since the spinner is divided into three equal parts, if the pointer is fair it is likely to stop on red the sane number of times it will stop on blue or on yellow. Hence it will atop on red $\frac{1}{3}$ of the tine. So we circle choice (b). 2. For the spinner in question 1 we say that the probability that the pointer will stop on red is
a) $x\left(\right.$ (b) $\frac{1}{3}$
(c) 0
(d) 1.

Answers- The correct answer is $\frac{1}{3}$. So we circle choice (b).
3. Think of tossing a ten-cent coin once. There are two possible outcomes. Either head shows up or a tall shows up.

What is the probability of getting hoad?
(a) $P(H)=K($ ( $) P(H)=X$ (c) $P(H)=0$
(d) $P(H)=1$.

Ansharia There are two possible outcomes and one of the possible outcomes may be a head. Hence the probability that a head will show up is $K_{0}$. We therefore circle choice (a).
4. Think of tossing $=d 1$ e once. There are 6 outcomes. These outcomes are 1, 2, 3, 4,

5 and 6. The outcomes are equally likely. What is the probability that the face that shows up will be one with 4 dots?
(a) $\frac{1}{12}$
(b) $\frac{4}{6}$
((c) $\frac{1}{6}$
(d)
$\frac{6}{6}$
inner. Since there are 6 outcomes, all equally likely, the probability that the face that shows up will be one with 4 dots is $\frac{1}{6}$. So wo put a circle around choice (c).
2. Write $\frac{9}{7}$ as a mixed number.
a) $1 \frac{2}{7}$
(b) 2
(c) $\frac{2}{7}$

2. Study the two apinners above. Suppose a pirate captain aid to you "I will give you Just one chance on a spinner. If the pointer stops on blue, I will push you into the sea. If it stops on red, you may go free." Which spinner would you choose?

## Which spinner would you choose?

(a) Spinner 1
(b) Spinner $B$
(c) None of the spinners.
3. Lumber has 3 green marble and 2 blue ar marbles in his pocket. How many marbles aust he remove to be sure of getting a blue marble?
a) one
(b) at least 2
(o) more.
4. Omuggu spins the pointer of a spinner 100 times and gets 35 reds. Which of the following efatoments is likely to be true? Put a circle around the letter that is likely to be tree.
a) The dial of the spinner is all red.
b) The dial of the spinner is K blue.
c) The dial of the spinner is $\frac{1}{8}$ red.
d) The dial of the apinner is $\frac{1}{3}$ red.
5. Ateke spins the pointer of a spinner 100 times and gets 25 red, 25 blue and 50 yellow. Which of the following statements is true?
a) The dial of the spinner is $X$ yellow.
b) The dial of the spinner is $\frac{1}{3}$ green.
c) The dial of the apianer is $\%$ blue.
d) The dial of the epinner is all red.
6. You wish to get exactly 5 reds and 5 blues in 15 apine of aplaner. Which of the following dials could give this reault?
a) Oac-balf red and one-balf blue.
b) Onc-third red, one-third blue and onothird yellow.
c) One-fourth red, one-fourth blue and one-hall yellow.
d) Ono-fifth red, two-fifthe blue and twofifthe jellow.
7. In which of the following is the chance of red equal to $k$ ?
a) One chance in two of red.
b) Two chances in four of red.
e) One chance in five of red.
d) Tho chances in eight of red.
8. Which of the following spinners is likely to give about the same number of reds as yellew?
a) One-half red, one-fourth yellow, onefourth blue.
b) One-third red, two-thirde jellow.
c) Ono-thind red, one-third jellow, ons-third blue.
d) Four-ififts jellow, one-fifth red.
9. If the dial of a spinner is all red, we say me chance of red is equal to s
a) Any other chance.
b) One chance in two.
c) Ono-half.
d) One.
20. If the dial of a spinner is all blue, wo say the chance of red is equal to s
a) One
(b) zero
(c) one chance in one
d) one-half.
11. Awiaja and Onuteimi each have one white and one green marble. âwinja picks one of her marbles without looking and then Omutbimi place one of hers. The lour possible outcomes are listed in a table below:


| White | White |
| :--- | :--- |
| White | Green |
| Green | White |
| Green | Green |

If the two girl a pick the marbles at the sane time, their chance of picking a white marble is equal to s
a) Any other chance.
b) One chance in two.
-) One chance out of one.
12. Tabu's bag contains three marbles, onomred, one white and one blue. If Tabu chooses one marble without looking, what is the probability that the marble Tabs chooses is red?
(a) $\frac{2}{3}$
(b) 1
(c) $\frac{1}{3}$
(d) 0.
13. The dial of the spinner shows on the right 1. divided into six equal regions. Panto spins the pointer of this spinner once. What is the probability that the pointer will stop on 3.
a) $\frac{2}{3}$
(b) $\frac{1}{6}$
(c) $\%$
(d) 1.

14. Tho table below show the possible outcomes 15 the pointer of the spinner show on the left is apus twice. The epinoor is divided Into two equal parts.


What is the probability that the pointer will atop on red the lirat time and on blue the second time, 1.e. what is $P(R B)$ ?
a) $\frac{1}{6}$
(b) $x$
(b) $\%$
(d) 0.
15. The table below show all the possible outcomes when two coins are tossed.


What is the probability of getting a head and
a tail?
a) $x$
(b) $x$
(c) $\frac{1}{8}$
(d) 1.

## APPENDIX CP

## PROBABILITY

## POST-TEST



Road the followlus instructions carefully before jour begin the teat.

1. Attempt all questions.
2. Write jour answers on the question paper, you should circle the letter of the correct answer of jour choice.
3. Do jour rough work on a separate sheet of paper, then write your answer on the question paper Example
4. Think of tossing a 10-cent coin once. There are two possible outcomes. Either a head show up or a tail shows up. What is the probability that a head will show up?
(a) $P(H)=k$
(b) $P(B)=\psi$
(c) $P(H)=0$
(d) $P(H)=1$ 。

Anevers - There are two possible outcomes and one of the 2 possible outcomes may be head Hence the probability that a head will show up ia $\%$. Wo therefore circle choice (a).

1. If an event is certain to occur, its probability is
a) 0
(b) $/ \%$
(c) 1
(d) Greater than 1.
2. If an event can never happen, its probability is
a) 0
(b) $x$
(d) 1
(d) Greater than 1.
3. A bax of marbles contain g 7 blue marble a and

11 white marbles. Betty draws one marble from the box without looking. What is the probability that the marble drawn is white?
a) $I$
(b) $\frac{7}{18}$
(c) $\frac{11}{18}$
(d) $\frac{11}{7}$
4. If the set of possible outcomes for an experiment consists of four equally likely outcomes, then the probability of each outcome is
a) $\frac{4}{4}$
(b) $x$
(c) 0
(d) Greater than one.
5. The probability of throwing exactly four heads and one tail in a toss of fire cooing is $\frac{5}{32}$. What is the probability of mat throwing four heads and one tall?
a) $\frac{5}{32}$
(b) 1
(c) $\frac{22}{32}$
(d) 0 .
6. Think of opining this spinner once. Each small section is $\frac{1}{10}$ of it.
$P($ Blue $)=$ $\qquad$

a) $\frac{1}{10}$
(b) $1 / 2$
(c) $\frac{9}{10}$
(d) 5 .
7. If you spin the pointer of apinner 100 tines and get $25 \mathrm{red}, 25$ blue and 50 yellow, which of the following statements is true?
a) The dial of the spinner ia $\%$ yellow.
b) The dial of the spinner is $\frac{1}{3}$ green.
c) The dial of the spinner is $\alpha$ blue.
d) The dial of the spinner is all red.
8. When a die is tossed once, what is the probability of the outcome "greater than 2 "?
a) 5
(b) $\frac{2}{3}$
(c) 6
(d) 1.
9. I1 you got exactly 5 reds and 5 blues in 15 aping of a ep inner, which of the following dials could give this result?
a) $K$ red and $\%$ blue.
b) $\frac{1}{3}$ red, $\frac{1}{3}$ blue and $\frac{1}{3}$ yellow.
c) $\%$ red, $\%$ blue and $\%$ yellow.
d) $\frac{1}{5}$ red, $\frac{2}{5}$ blue and $\frac{2}{5}$ yellow.
10. Porto spins the pointer of a spinner whose dial 1: divided into six equal region numbered 1, 2. 3. 4, 5, and 6. What is the probability that the pointer will stop on 37
a) $\frac{1}{3}$
(b) $\frac{1}{6}$
(c) $x$
(d) 1.
11. In a gambling fane where one coin is to be tossed, a player wins if he scores two heads and one tail. How many times must he toss the cole?
a) 8 tines
(b) once
(c) three tines
d) twice.
12. In the gan "roses two dice". you win 11 each die has 1 on the top laces the other player wee 11 one die has 1 , and the other die has 2.

What is the probability that the other player wine?
a) 3
(b) $\frac{2}{3}$
(c) $\frac{2}{18}$
(d) $\frac{2}{36}$
13. The dial of a spinner is $k$ white. $X$ red. $\frac{1}{8}$ blue and $\frac{1}{8}$ Fellow. What is the probability that the pointer of the spinner w111 stop on either white or blue if the spinner in spun once?
a) $\%$
(b) $\frac{1}{8}$
(a) $x$
(d) 5
14. Oriya has three bare in his house. In the Prat bags there are one red and one blue marbles; in the second bag, there are one red and one blue marbles and the bag contains one red and one blue marbles. Okiya picks a marble from each bag without looking. What Is the probability that be w111 draw at least a red marble?
a) 1
(b) $\frac{7}{8}$
(c) $\frac{3}{8}$
(d) 0 .
25. A epinner whose dial is $\frac{1}{3}$ red. $\frac{1}{3}$ blue and $\frac{1}{3}$ yellow is spun twice. What is the probability of getting both rad in two apian of the spinner?
a) $\frac{1}{9}$
(b) $\frac{2}{9}$
(c) $\frac{1}{3}$
(d) $\frac{2}{3}$
16. A spinner whose dial is $\frac{3}{8}$ red and $\frac{5}{8}$ blue and a spinner whose dial is $\times$ blue and $\frac{3}{4}$ red are apus at the sane time. What would you do to find the probability of both red in two aping?
a) add $P$ (Red) on first spinner to $P($ Red ) on second spinner.
b) subtract $P($ Red ) on first spinner from $P$ (Hod) on second spinner.
c) $P(\operatorname{led})$ on list spinner multiplied by $P($ Red $)$ on second spinner.
d) Divide $P($ Red $)$ on second spinner by $P$ (Red) on first spinner.
17. A coin is tossed once, and a spinner whose dial is coloured Red, Blue and Follow ia spun once. What is the probability of not getting a head on a coin and a blue on a spinner
a) $\frac{1}{3}$
(b) $\%$
(c) 5
(d) $\frac{2}{6}$.
18. Two dice are tossed together. What is the probability of getting either a sun of 6 or a bu of 77
a) $\frac{1}{6}$
(b) $\frac{2}{3}$
(c) $\frac{11}{36}$
(d) 36
19. There are three boys and three girls in a house. Their mother wishes to take any two of thea at a time for a walk in town. In how many different ways can she select two children to go with hers


The planer above is divided into six equal regions. Use it to ind the probability of either Rod or 1.
a) $\frac{2}{3}$
(b) $\frac{1}{6}$
(ब) $\frac{1}{3}$
(d) $K_{0}$

## APPRNDK $2 I$



## ARITHMETIC REASONING

## Ingtruction

This seotion consists of probleng in
arithetic. Hewever, you do not have to find the angwer to each problem. Iou only have to tell how the anewer could be found.

Erample 0.
Janc's father was 26 Jeare old when she was born. Jane in 8 jeure old. How old 18 her father now?
(A) subtract
(B) divide
(C) add
(D) Eultiply.

Jane's father is now 34 jearn old. But, jou are not asked to fisd this. You are asked hoy to find this. Since his age is found by addine 26 and 8, choice (C) should be circled.

## Examh 00

Denke are priced at 8hw. 40/= each. If bought in lots of 4 , the tetal price is reduced by She. 20/-. How much would 4 deake cost?
(1) divide and add
(B) uultiply and cultiply
(C) aubtract and divide
(D) Eultiply and subtract.

One way to solve the problen would be to multiply She 40/= by 4 and then subtract 20 from the product. 80 you should circle choice (D).

Athough some problene may be worked is nore than one way, only one of the ways will be given among the answer choices.

You should only guess if you can rule ort some of the choices. DO NOT guese wildly.

You will have 40 gimetes for this section. If you finish before time is called, check your work.

DO NOT TURN THISE PAGE UNIIL ASKED TO DO 30 .

1. There are 4 quarts in a gallon and 4 cups in a quart. How nany cups are there in a gallon?
(A) add
(B) subtract
(C) nultiply
(D) divide.
2. An electric planer is set to remove. 02 of an inch each time a plece of wood is passed through it. If a board is put through 7 times, how much will have been removed?
(A) multiply
(B) aubtract
(C) divide
(D) add.
3. There are 54 children at a gmall holiday camp. If there are 33 boye attending the camp, how many campers are girls?
(A) add
(B) multiply
(C) subtract
(D) divide.
4. A man wants to seed a lawn arousd his now home. His plot is 120 feet by 90 leet ( 10,800 eq. feet). His house is centered on the lot and occupies 2,785 sq. leot. How many square leet of ecround nay be put into lawn?
( 4 ) add
(B) divide
(c) multipls
(D) ubbract.
5. A wholesale frult dealer sells orangen at 72 cents per pound and lemons at 31 cents per pound. One day he sold 79 pounds of each type of srust. How much money was taken in?
(A) add and divide
(B) add and multiply
(C) multiply and subtract
(D) divide and divide.
6. A ejclist in an international bicjcle race has covered an average of 9 miles every 20 rinutes. If ho con maintain the sane average epeed, how long will it take him to cjcle the remaining 84 miles of the race?
(A) divide and multiply
(B) aubtract and divide
(C) add and aubtract
(D) divide and add
7. a grocer cells oranges for 59 cente a dozen. The oranges cost hil 33 conts a dozen. Hov much profit is there on each orange?
(1) uubtract and multiply
(B) divide and aubtract
(C) add and divide
(D) aubtract and divido
8. 4 boy works in a shop ufter school for a total of 20 hours a weok. He also works 8 hours on Saturdays. How much is he being paid per hour, If he makes She. 20/70 per week?
(A) maltiply and mubtract
(B) add and divide
(C) divide and aubtract
(D) add and multiply
9. A housewife took a job which pays She.65/00 per weok. After paying taxes she is left with 76\% of her salary, and each week she spends a total of Sha. 56/00 on lunches and bus fares. How much does her job increase the fanily
income?
(A) divide and aubtract
(B) subtract and nultiply
(C) add and divide
(D) multiply and gubtract
10. A rectangular underground reservoir is 25 feet deop and containe $2,000,000$ gallons of water, when it is full. The short rains filled the reservoir, but a drought in Jenuary caused the water level to drop 8 feet. Approximately how many gallon of water were consumed during the drought?
(A) subtract and divide
(B) add and subtract
(C) divide and multiply
(D) subtract and multiply.

## APPENDIX 12

## IITONSTIC TET IN VULGAR PMACTIONB

## INES

$\qquad$
BOL OR GIRL $\qquad$ COB $\qquad$
$\qquad$

## REND CAREFUNTI

a) This test is designed to holp jour teacher discover the difficulties fou experience When working with fraction.
b) You should wort quickly and carefully.
c) Were possible reduce fraction in the anvers to lowest ter ne.
d) You are allowed 40 minute n to answer these questions.

(b) $\frac{2}{9}+\frac{1}{9}=$
c) $7+\frac{2}{3}=$
(d) $2_{6}^{5}+5=$
2.a) $1 \frac{5}{8}+\frac{1}{8}=$
(b) $\frac{3}{9}+1 \frac{2}{9}=$
c) $3 \frac{7}{10}+1 \frac{3}{10}=$
$3 . a) 3 x+25=$
(b) $\frac{4}{9}+\frac{5}{9}=$
e) $\frac{27}{8}+11 \frac{1}{3}$ =
a) $2 x+2 \frac{4}{5}+3 \frac{7}{10}=$
(b) $2 k+3 x+2 \frac{2}{5}=$
e) $3 \frac{7}{10}+4 \frac{8}{15}+2 \frac{5}{6}=$
5. a) $\frac{2}{9}-\frac{2}{9}$
(b) $\frac{9}{10}-\frac{3}{10}=$
c) $\frac{37}{8}-\frac{5}{8}=$
6. a) $5 \frac{8}{9}-2 \%$
(b) $5 / 2-3$
c) $6-5 \frac{5}{8}$
7. a) $5 \frac{3}{10}-\frac{7}{10}$ -
(b) $6 \frac{5}{12}-\frac{312}{15}$.
e) $4 \frac{7}{25}-\frac{7}{9}=$
8. a) $x-\frac{1}{8}$
(b) $1 \frac{2}{5}-1 x=$

## APPENDIX DZ

## nopraig wick ivotbens

LuNE
BOL OR GIRL
AGE $\qquad$

80800L $\qquad$
CLASS
DATE

## RES CARLTUNY

There are 10 questions about working with mubere. Each question ha live answer choices. Ion should circle the letter in front of the answer jour choose.

Here is an example of how fou should mark Jour anowesi.

## Example

Subtract 918 from 1,725.
a) 819
(b) 807
(c) 928
d) 1,018
(e) 1,622.

The answer is 807, so (b) has been circled.

You are to do an many questions an jor can. Do not spend too much time on any one question.

You are allowed 40 minutes to work out these problems.

The first two questions are about a ringtone game. In ringtoss each player gets three rings to toss. Hings on the peg win 23 pointy each. Rance off the peg lose 10 points each.

1. Bernina has two on and one off. How many points does she got?
a) 5
(b) 15
(c) 36
(d) 40
e) 60 .
2. Otieno has one on and two off. How many points does he get?
a) 3
(b) 20
(c) 25
(d) 40
e) 45.
3. What number does $S$ stand for if$3 \times 4 \times 5=12 \times \mathrm{S}$ is a true statement?
a) 20
(b) 0
(c) 3
(d) 4
-) 5 .
4. Which formula would jour use to find how many tamps each person should get if 31 people share equally a package of 2325 stamp oi
a) $32 \div 2325=n$
(b) $2325!31=n$
(c) $2325-31=n$
(d) $31 \times 2325=n$
(o) $n-2325=31$.
5. Suppose we decide to withe fractions in a different way. For example, instead of $\frac{2}{3}$ we would wite $(2,3$ ) and instead of $\overline{\overline{7}}$ we would mile $(7,5)$. What would be the sum of $(1,5)$ and $(3,5)$ ?
(a) $(5,5)$ (b) $(4,5) \quad(0)(3,10)$
(d) $(4,10)$
(d) 3,25).
6. $1 \times 2=0$, $2 \times 2=3,5 \times 6=29$, $7 \times 2=13,4 \times 4-15,9 \times 2=17$. What does $6 \times 3$ equal?
(a) 6 (b) 3
(c) 9
(d) 17 (e) 18.
7. Which of the following will always produce an odd number?
1) The sur of two odd numbers
ii) The sur of any 3 even numbers.
iii) The sum of and 3 odd numbers.
(a) 1) only
(b) (ii) only
(c) (iii) only
(d) 1) and
(ii) only
(a) 1) and (iii) only.
8. The sun of the odd numbers less than 4 and the oven numbers lems than 9 se
(a) 11
(b) 13
(c) 24
(d) 42
(0) 45
9. If you multiply a number less than 2,000 by one less than 100, the greatest possible answer you could get is
a) 98,901
(b) 100,000
(c) $1,000,000$
d) 999,901
(e) 99.999.
10. How many pieces of wood will you have if you cut across a lone board 17 times with a saw?
a) 16
(b) 17
(c) 18
(d) 29
e) none of these.

## AFPENDIX E

## GILNST RLADING

2NTE
BOI OR GIRL AGB $\qquad$

89HCOL $\qquad$
CLAS8 $\qquad$
DATE $\qquad$
(Time - 30 Minutes)

Read carefully but quickly each paragraph and the question at the end of it. Write the answers to the yuestions on the space provided. Write only one word answer whenever possible.

Paragraphs (a) and (b) are examplea to be done by the teacher and the class.
(a) I have a oat. It ia black and white. It is ane jear old. It sleepe in a box. It likes to play with a ball of wool.

Where does the cat sleop?
(b) Breyy now and then along the roads we see low wooden houses with tightly shut windowe and ilttle garrens stocked whth slowern.

Choose the word below that tells about the window, and write it on jour answer paper.
hals-open; opens closed apart

1. I an a wild bird. My home is in a tree. I can 51 y high in the air. I can sing a Eong.

Guostions Where is the bird'a home? Anewers
2. Wo have a baby. When we speak to hil he waves his little hand. He has ten teeth. He sleeps in a oot most of the day. Question: How many teeth has the baby? Angwer:
3. It was gotting so dark that Alice thought there mat be a storn coaing on. What a thick black cloud that is!" She oried. "And how fant it comes! Why, I do believe it's got wings."

Guantions Do you think the sun was shining?
Yes
No
Cannot toll.
Put a circle around the answer that is appropriate.
4. Otieno picked up a mall bac full of money and wont off with a light heart. His eyes spartied for joy and he said to hinself. "I aust have been born in a lucky hours everything that I wish for comes to mof itself."

Guestions Has Otieno happy or unhappy? Angwer:
5. In some cities coloured lights are used to direct the cars at cross streots. A red light neans "Stop" an orange light means "Get Ready," and a greenlight means "Go". Questionss What light is uged for "Get Heady?" Answers
6. Last Monday we went to the 200. Wo spent much time in front of an iron cage which held seven monkeys. They made us laugh when they put out their paw for nuts.

Questions What was the monkey's cage made 0 ? Answers
7. There was once a shoemaker who worked very hard and was very honest, but etill he could not eam enough to live on, and at lant 4.

- 406 -
all he had in the world was gone except
enough leather for one pair of shoes.
Choose the word below that tells what the
shoonaker was and put a ofrole round it
lasy hardworking
proud $\quad$ dishonegt

8. When a duck wants to cone to reat on water it draw its head backward, tilt: ite body upward, thrusts ite foet forward and apreads its tails outward. Choose the word below telling how the tuck places its head. Put a circle around it.
upward forward backward
dowaward
9. I can exip, I go to sohool overyday, I wear a pretty dress, I have a long hair.

What an 18
10. Long ago there lived on the sea coast of Japan a young man named Yaina, a kindly follow and elever with his rod and line.

In the space proolded below write the word
Yaina. If you think he was a fighernan put
a Line wider his names if you think ho wee not put a cross under his name.
12. The dar light is dying,

Ama y is the West.
The wild bleeds are flying,
In ellence to rest.

Do these limes tell about evening or morning?
12. Over the grazing field,

In the reeds on the shore,
Ied a mother watermrat,
And hear little water mate four.
How many matomrate altogether lived in the reeds?
13. A sailor dropped the captain's silver teapot into the sea. The captain went to the sailor and said to hin, "You lot my teapot rall into the sea, did jour not? It is lost." "Ho, no," arid the sailor, I know where it is. It in at the $\qquad$ of the sea."

Write the word that has been left out.
14. If jou are walting on shore for a ship to cone in the ilrgt thing jou see is the nolze, later the funnels and nasts cone 1. Uisht, and lastly the hall of the ohfp 1tself 1s seon.

Suppose jou ware watohing a ship leaving the land. Choose the word below thut telle jou the last thing you would see. Put a clrcle around the word jou have chosen.

| people nasts | make |  |
| :--- | :--- | :--- |
| funnels | mil |  |

15. Bohlad the little house were orange treen, a mange tree and two or three paw paw trees. Thon came a strotoh of rough grass and a atose wall with a gate leading into the panture.

Wes the stone wall in front, or at the alde -I the house?
16. A field monse had a friend who lived in a bouse in town. Now the town mouse was anked by the fleld mouse to dine with hin, 80 out ho wont and sat down to a meal of wheat.

Whore did they dine? At the fiold mouse's home, or at the town mouse's home?
17. Upos a mountain height,

Far irom the sea,
I found a shell,
And to $\mathrm{my}^{2}$ listening ear the lonely thing,
Erer a song of ocean seemed to sing,
Ever a tale of ocean seemed to tell.
Which seened to sing a song? The mountain, The sholl, or the ocean?

## APPENDIX FI

12ME $\qquad$
BOI OR GIRT $\qquad$
AOE $\qquad$ DATE

## GHITNDE TOWARD MTHVMINICS

This is not a test. There are no "right" or "wrong" anawors. Just anmer the questions cs honestly as jou can.

In each question you are asked to tell how you foel about each statonent by solecting one of the waya given beneath the statenant.

Here in a practice samples
examle 00
It is nore fun to play hockey than to dance.
(d) Stronsly acree
(B) Agree
(C) DLEAgree
(D) Strongly disagree

Which one of the four ways tells best how you feel abort the statement?
(A) $0 x$
(B) $0 x$
(C) or
(D) Put an $x$ on the letter of the anavor you chooce.

How do the sane for the following statement. Work carefully and guickly. Do not apend a long tino on one question. Please answer all the Iteas and give only one answer to each.

## All answers must be on the augstion papose

1. I hate Mathematics and avoid using it.
(A) Btrongly Agree
(B) Agree
(C) Disagree
(D) Strongly Disagree
2. I have never liked Mathemation.
(A) Strongly Agree
(B) Agree
(C) Etrongly Diangree
(D) Dieagree.
3. I an afraid of doing word probleas.
(A) Strongly Agree
(B) Agree
(C) Strongly Disagree
(D) Disagree
4. I have always been afruid of Mathenatics.
(A) Strongly Agree
(B) Agree
(C) Disagree
(D) Strongly Disagree.
5. I cas't see much value in Mathonatic..
(A) Strongly Agree
(B) Agree
(C) Disagree
(D) Strongly Disagree
6. I avold Mathematice because I am not very good with maberm.
(A) Strongly Asfree
(B) Agree
(C) Disagree
(D) Strongly Disagree.
7. Mathomatics is something you have to enjoy oven though it is not onjojable.
(A) Btrongly agree
(B) Agree
(C) Disagree
(D) Strengly Disagree
8. I do not fool sure of nyself in Mathenatics.
(A) Strongly Agree
(B) Agree
(c) Disagree
(D) Strongly Disagree.
9. I do not think Mathomatice is run, but I alvaye want to do well in it.
(A) Strongly agree
(B) Agree
(C) Disagree
(D) Strongly Disagree
10. I an not onthuaiastic about Mathenatice, but I have no real dislike for it oither.
(A) Strangly Aigree
(B) Agree
(C) Msagree
(D) Etrongly Diaagree
11. I like Mathematics, mut I like other subjects just an woll.
(A) Btrongly Agroe
(B) Agreo
(C) Disagree
(D) Strongly Disagroe
12. Mathematics is important as any other subject.
(A) Stronely Agree
(B) AEree
(C) 8trongly Disagree
(D) Disagree
13. I onjoy doing problens when I know how to work them woll.
(A) Strongly Agree
(B) Agree
(C) Dhsagree
(D) Stronsly iviarereo

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14. Sonotines I enjoy the challenge presented of Mathe problen.
(A) St50agly 48200
(B) 48500
(C) Disagreo
(D) Strongly D1sagree
15. I 11ze Maths because it is practical.
(A) Strougly Agree
(B) Agree
(C) Dinagree
(D) Btrongly Disagree
16. Math 18 very interestinge
(A) 8trongly figroe
(B) Agree
(C) DLsagree
(D) Btrongly Dlsagree
17. I enjoy seeing how rapidly and accuratoly.

I can wort Mathe problome.
(A) 8tringly Agree
(B) Agree
(C) Disagree
(D) 8trongly Disagreo
18. I vould ilke to spend more time in school working Mathe.
(A) 8tromily Agree
(B) Agree
(C) D2848ceo
(D) Strongly ilsagree
19. I think about Maths problem outside school and like to worl then out.
(A) Btrongly Agree
(B) 48200
(C) DLsagree
(D) Strongly DLeagree
20. I mever get tired of working with numbers.
(A) Etrongly Agree
(B) Agree
(C) Dlaugree
(D) Strongly Disagree
21. I think that Mathematics is the nost enjojable wibject.
(A) 8trongly Agrec
(B) AgTeo
(C) Masagreo
(D) 8tronely Dlsagree
22. Mathomatice thrills mo, and I like it better than any other aubject.
(A) Strongly Agree
(B) Agrea
(0) Disagreo
(D) 8trongly Disagreo

## AHPMIDIX 72

## ATMTTUDE INVENRORX

The atatenents below represent varying
attitudes towards the use of programed matorlals or teaching nachines as means of studying a subject. Read each statement and indicate the extont to which jou agree or disagree by cireling $\mathrm{SA}($ Strongly Agree), $\mathrm{A}($ Agree ), O(Dndooided or Reutral), D(Disagree), or 8D(Btrongly Diagree).

1. Classes in which programmed nateriale are used are dull and uninteresting.
SA
$A$ U
D
SD
2. I foel that using programed materials is the nost effoctive nethod of studying that I have over used.
8A A D D D SD
3. I an glad that I an not using programod matorials in more olasses that I an at present. 8A A U D 8D
4. I do not like to work with programmed materials.
SA
$\triangle$
0
D
$8 D$
5. School would be more interesting if programed materials were used in more clasaen.
$81 \quad 1 \quad$ U D SD
6. I wish that I could study programed naterlale 1. 5 other classes.
81
A
(J
D
SD
7. Ding programed materials results in too mach mated time.
81
A
v
D
SD
8. Doing programmed materials is interesting because fou have to keep thinking.
81
A
0
D
SD
9. I would rather be working with a group of clagrates than working alone with a programmed textbook.
SA
$\Delta$
U
D
SD
10. When I use programmed materials I can kop interested in work.
SA
A
U
D
$8 D$
11. When I use programmed materials I understand everything that I study.

81
A
0
D
SD
12. I would rather have a teacher explain the subject than be left on my own with a programmed text.

SA A D D SD


[^0]:    The findinge of this study have revealed that the XPI and CI mothods are powerful teaching aids for higher cognitive abilities. Programed learning, however, ecores well over traditional lesraing in asving student time. The time olement coupled with its effectiveness as learning tool argue woll for the establishment of programed workshops in a country such as Konya where the population of prinary school children cannot match the output of trained teachers.

[^1]:    The inomguration of a aew ara of procramed Loaztiog care about with Profencor indomerie ancention in 2954 that tho experfental

[^2]:    9
    Mondoverart, Boles the effcote on oomeatiomily tareght olzhtb-crede meth following goventhogrodo path. per arithnotio seachor Vol. 12. kN. 8, 1953. ppali - 616.

[^3]:    11
    Inhiwand, G. B. : ises Disferances in the Loarnines of Mathemation vony Kenyen High Eohool Studeate.
     mingt 1984.

[^4]:    -significant at the 938 Conifdence Intarval.
    

[^5]:    It was mentioned in section 1.4 that it

